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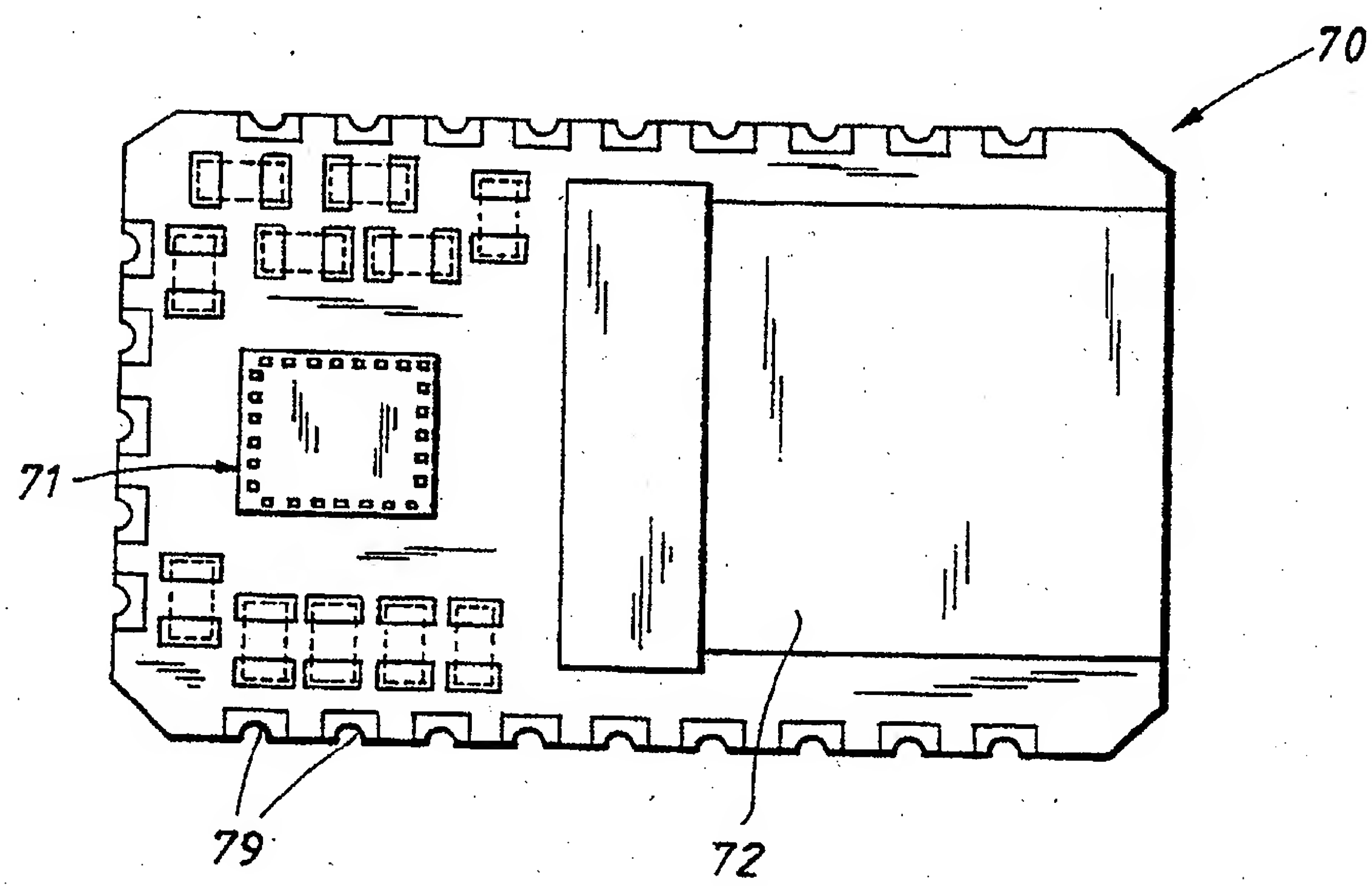

(57) Abstract

The present invention relates to a component module (70) comprised by at least one internal or external carrier substrate, at least one circuit (71) with at least thereto belonging surrounding components or components (72). The circuit (71) is directly mounted to the carrier substrate and the component module (70) comprises an enclosing device and furthermore is so formed that it can be directly mounted onto an external carrier substrate and or a printed board externally having the form and dimensions of

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Component module

TECHNICAL FIELD

The present invention relates to a component module according to the first part of claim 1 as well as to component modules comprising transceiver modules according to the first part of claim 28. When fabricating different components such as for example opto-components but also for example small oscillators, filter, power units or adaption units etc, it is of importance that the distances between circuit and components are as short as possible, that the geometrical dimensions are as small as possible among others to ensure that the electrical functions will be as good as possible, the need of space is to be kept down, parasitic capacitances are to be kept as low as possible etc. Also the cost of the fabrication method will be of great importance. As, for example, opto-components are concerned, the requirements are high especially when high speeds are involved. For economic reasons it has therefore been tried to apply conventional fabrication methods as far as possible, but this involves problems at higher speeds among others depending on the physical dimensions becoming to large.

The requirement that the distance between circuit and component is to be as small as possible difficult to combine with the requirements that the components are to be encapsulated in order to achieve a sufficiently good environmental protection. This means that concessions are necessary either as far at the distances are concerned or the encapsulation or the shielding or a compromise where both the distances will have to be increased as well as the encapsulation will be poorer. Too big geometrical dimensions means a lowered performance. It is also of importance that a fabrication method is such that testing of the components can be carried out in an as easy and cheap way

as possible so that the discarding costs will not be too high which would be the case if testing only can be carried out on a high level or with essentially completely finished products. Particularly it means high costs if the series which are to be made are small.

What has been said above is generally valid for different components as well as it is valid for the particular embodiment relating to a transceiver. Normally the circuits are mounted in conventional standard capsules but if those have been mounted on the printed board and from there been connected to the opto-components to be driven by the circuit or which are driven by the circuit, it is often the case that the distance between the circuit and surrounding components has become to long. A number of the problems mentioned above occur upon construction of fibreoptical high speed links where furthermore problems are present regarding decoupling of feeding voltages, keeping geometrical dimensions such that the electrical functions can be optimized, enabling lowering of EMI-problems as well as the need of space etc. The costs for fabricating such will often be high and since it is difficult to test involved components at an early stage, the costs will be further increased.

STATE OF THE ART

Different building techniques for a number of different components are known. One object is to keep the distances between circuit and components as short as possible at the same time as the components are to be encapsulated in order to achieve a good environmental protection (the components may comprise fibre optical components but this is true also for other components). There has been attempts to solve this problem in two different ways. According to one solution the starting point is to try to get a distance which is as short as possible between the components through keeping them non-encapsulated; this is from an electrical point of view optimum, whereafter one common capsule is arranged to cover components as well as circuits.

According to a particular embodiment big hermetical covar cases are used where the opto-components can be mounted non-encapsulated and where circuits with indispensible components are mounted on a ceramic substrate. Those solutions are electrically satisfying but expensive since the substrate around which is built is made of ceramic and specially adapted for the intended application and since it is required an hermetical capsule which covers the totality. With this building technique problems furthermore arise as far as testing is concerned since it is difficult to carry out any tests before the whole function block essentially is finished which in turn leads to very high discarding costs since errors and foults may lead to the whole function block having to be discarded.

According to a further building technique involved components are encapsulated separately whereafter they are mounted as close to each other as it is practically possible with the applied building technique. This building technique which is based on making use of more standardized components which furthermore may have been tested gets cheaper at the same time as the performance will be lowered amongst others due to too large geometrical dimensions and to long distances.

With known so called transceiver modules the optical components are non-encapsulated and built together in the form of a so called wavelength division multiplexor module (WDM-module) which in combination with electrical transmitter and receiver modules is arranged in a hermetical covar case. According to a known embodiment the electrical modules are built up on a carrier substrate of ceramic with connections intended for bonding. This building technique is complicated as well as expensive and therethrough also the transceiver modules get complicated and expensive.

According to another known device a comparatively cheap link is fabricated from a conventionally made transceiver board with common, commercial components. This device however, exhibits a

bad performance particularly due to the distances between different components being too large. Furthermore the link requires a lot of space.

EP-A-0 437 161 shows a transceiver fabricated through a so called double-sided mounting with shielding. In this transceiver the distances between the circuit and optical components will be too big as well as it is not possible to get the transceiver itself as small as this would be desired. The apparatus will furthermore get even more complicated at high speeds and for mounting contacts on the card itself are used which is disadvantageous at high speeds.

SUMMARY OF THE INVENTION

Is the object of the present invention to provide a component module which has small dimensions, is cheap and easy to fabricate, is so exclusive that it can meet high requirements and is so formed that it can be handled as a conventional component by the building technique or the standard building technique that is used without any influence on the performance of the building technique. It is another object with the present invention to provide a component module with which a high performance can be reached even at high speed applications, which is easy to mount and at which it is possible to mount parallelly with a number of other components modules in a greater number. It is another object of the invention to provide a component module which enables a building technique a method wherein testing is facilitated since the per se functionally extensive component modules may be tested using so called standard sockets.

The invention furthermore intends to provide a component module which should be as general as possible and therethrough suitable for a number of different applications e.g. since series fabrication is possible for each respective type of component module. A further intention with the invention is to provide a component module which can be formed in many

different ways and be applied within a number of different areas and which can be easily tested and which is so cheap that it can be discarded of without testing having to be done on a circuit level.

Furthermore the component module given in the invention will enable an electrically optimized building technique.

A further object of the invention is to provide a transmitter, a receiver as well as a transceiver which fulfills the requirements given above and through which a cheap high performance link can be obtained. It is also an object to provide a transceiver which offers a good shielding between transmitter and receiver.

These as well as other objects are achieved through a component module with the given characterizing features of claim 1.

A transceiver is given through the characterizing features of claim 28.

Preferred embodiments are given by the characteristics given in the subclaims.

According to the invention is particularly a component module provided wherein the high performance requirements have been concentrated to a geometrically small surface. Particularly the component module has external dimensions and appearance of a lead-less LCC-standard circuit (Lead-Less Chip Carrier) or a PAA-standard circuit (Pad Area Array). These are normally made of ceramic which has a heat coefficient different from that of the board of plastic. According to a preferred embodiment plastic is used instead of ceramic wherethrough plastic on plastic is obtained which is advantageous and wherethrough problems of heat expansion are avoided. However, also multilayer ceramic may also be advantageous. Therethrough the modules may even be made larger. The component module comprises particularly a small carrier substrate which may comprise a

printed board of e.g. plastic laminate or any other material with the circuits to be comprised being mounted directly on the circuit through a so called chip-on-board technique (COB-technique) together with further wanted or needed components. The component module is conveniently covered by a protecting plastic drop which is said to comprise the encapsulation and which gives a good environmental protection which at least corresponds to conventional plastic encapsulation.

Through the COB-technique is gets possible to obtain physically small dimensions and short distances between the components since the circuits are mounted directly onto the carrier substrate or the printed board without any encapsulation. Through an advanced component module comprising thin leads, ground and feeding planes arranged on top of each other with very small components and with integrated circuit(s) which then is covered by for example the plastic drop and which externally has the given standard formate of a standard capsule, a good electrical solution is reached at the same time as a component module is provided which may be mounted with any encapsulated component; for example it can be mounted by a common technique, be tested with the help of conventional tools which are used for encapsulated components etc. Through the invention a component module is thus provided through which the current definition of capsules/components is widened since the component module comprises as well carrier substrate as components and circuit or circuits. In the case of optical applications the optical components are connected directly to the component module or mounted directly onto this.

According to the invention there are a number of different possibilities for forming of the component module. Among others the carrier substrate may be made in a number of different ways, for example materials different from the standard materials used for printed boards may be used - it is for example possible to use materials which have better characteristics at high frequencies than the standard materials. It is furthermore possible to integrate different

simple components in the carrier substrate such as for example small capacitors or inductors which may be made directly in the printed circuitry of the carrier substrate. It is furthermore possible that the carrier substrate has different numbers of lead planes depending on the requirements on wiring, feeding voltage decoupling etc. Particularly the carrier substrate may comprise several planes, with short distances between the planes etc. Further variations as far as the carrier substrate is concerned consist in that the carrier substrate may have different external dimensions and differently distances between contacts etc. However, through use of the dimensions given for standard capsules to make the modules fit in standard sockets and testing sockets, mounting machines, testing equipment etc. By building a so called multilayer structure with thin isolating planes the decoupling between the feeding planes in the module can be high as well as the impedance in ground plane can be low. Therethrough the card may work as a capacitor. According to the invention it is advantageous that involved wires are concealed or buried as well as it is convenient to utilize thermal vias for dissipation of heat from circuits etc. in order to compensate for the poor thermal conductivity of the plastic.

According to the invention the circuits may be bonded on to the carrier substrate by thin aluminum filaments in a manner known per se. This means that one end of a very thin aluminum filament is welded onto the small connection pads of the circuits whereas the other end of the filament is welded onto a connection pads on the carrier substrate. According to the invention it is also advantageous to, according to an alternative embodiment, connect the circuits to the carrier substrate for example through so called flip-chip technique where the circuit is turned upside down so that the connection pads of the substrate will be located directly under the connection pads of the circuit whereafter connection between circuit and carrier substrate is achieved through small plumber balls which either are situated on the connection pads on the circuit or the substrate which enables further reduction of the

component module. According to a particular embodiment optical, encapsulated components may be mounted directly on to the component module.

According to the invention it is furthermore preferable to try to reach a level of integration which is as high as possible, i.e. that the components which are located on the module apart from the circuit which are not indispensable but which contribute for obtaining optimum electrical characteristics should be located on the module as well as the carrier substrate should be adapted to the performance which is required and the cost which is reckoned with respectively which means that the substrate may be varied to comprise those layers and functions which are desired in order to reach the appropriate level for the application.

According to one embodiment of the invention the component module forms a transmitter module which more particularly comprises a transmitter circuit with the necessary surrounding components such as components for decoupling, terminating etc. The transmitter circuit itself comprises among others feeding electronic, clocking means, controlling etc. Furthermore the component module may be a receiver module which more particularly comprises a receiver circuit with necessary surrounding components, for decoupling, external time constants etc. whereas the receiver circuit comprises filter, decision circuit, clock recovery etc. According to the invention there is particularly provided a transceiver module according to claim 28 which comprises a transmitter module as well as a receiver module and which can be said to form a fibreoptical link terminal comprising electro-optic and opto-electric conversion respectively. The electro-optical conversion is hereby provided by the transmitter module and a transmitting diode belonging thereto (for example LD or LED). The opto-electrical conversion is provided in the same way by the receiver module and a receiver diode belonging thereto (for example PIN). In particular, the transmitter diode, receiver diode, wavelength dicision multiplexor and fibre connection can be said to form a so called wavelength division multiplexor

unit. This so called wavelength division multiplexor unit can be also be said to form a so called optical block. According to the invention it is convenient to utilize standard capsulated transmitter and receiver diodes respectively, particularly so called TO-18-capsules.

According to one embodiment of a transceiver module the transmitter modules are mounted on the topside of the transceiver module whereas the receiver modules are mounted on the underside of the same. Preferably the wavelength division multiplexor unit is so mounted that particularly the receiver diode, which may be a so called PIN-diode, is mounted in a lateral position and inserted through a hole in the carrier substrate of the transceiver module. This substrate comprises signal planes on its outer sides and power feeding planes and ground planes therebetween as a shielding between transmitter side and receiver side. This gives an electrical shielding between receiver and transmitter. By mounting of the transceiver module on a larger card a complete shielding of the receiver side is achieved due to the shielding from the topside of the module and on the sides arranged leads and underlying ground planes in the card onto which the transceiver module is mounted. Thereby the optical components may be connected directly to the transmitter modules and the transceiver modules respectively instead of via the carrier substrate of the transceiver. According to the invention it is furthermore possible to mount transmitter module as well as receiver module and wavelength division multiplexor unit directly onto a large card, i.e. without using the carrier substrate of the transceiver module. Then the transmitter module as well as the receiver module are mounted in the same way but on each one side of the big card. Even in this case the shielding between transmitter and receiver will be good since the laying ground plane will be large and extended. It is also possible with so called multiple arrangements.

Furthermore it is possible to mount transmitter module well as receiver module on the same side of the transceiver substrate. This is possible by rotation of the wavelength demultiplexor a quarter of a full turn (c:a 90°). Thereby it is also possible to mount everything directly onto the large card without the carrier substrate of the transceiver module.

According to the invention it would furthermore be possible to arrange a number of transmitter modules, receiver modules and wavelength division multiplexor units on one and the same transceiver substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will in the following be further described by reference to the accompanying drawings in an explanatory and by no means limiting way, wherein:

Fig. 1a illustrates an example of the topside of a receiver module based on a six-layer structure,

Fig. 1b illustrates layer 2 of the receiver module illustrated in Fig. 1a,

Fig. 1c illustrates layer 3 of the receiver module illustrated in Fig. 1a,

Fig. 1d illustrates a layer 4 of the receiver module illustrated in Fig. 1a,

Fig. 1e illustrates a layer 5 of the receiver module illustrated in Fig. 1a,

Fig. 1f illustrates the bottom layer 6 of the receiver module illustrated in Fig. 1a,

Fig. 2a illustrates an example of the upper-side, layer 1, of a transmitter module likewise base on a six-layer structure,

Fig. 2b illustrates an example of a layer comprised by the transmitter module illustrated in Fig. 2a, layer 3,

Fig. 3 illustrates schematically an example of a component module (COB-module) with eight layers,

Fig. 4a illustrates a first example of a transceiver module seen from above,

Fig. 4b is a sideview of the transceiver module illustrated in Fig. 4a,

Fig. 5a illustrates a second embodiment of a transceiver module seen from above,

Fig. 5b shows a sideview of the transceiver module illustrated in Fig. 5a,

Fig. 6 illustrates a transceiver module with so called planar mounting,

Fig. 7a shows a transmitter module with an opto-component mounted directly thereonto,

Fig. 7b shows a receiver module with a surface mounted opto-component,

Fig. 8a shows an example of a component module with in the carrier substrate integrated components such as for example inductors,

Fig. 8b shows a cross-section of a toroid with shielding layer in a different scale.

DETAILED DESCRIPTION OF THE INVENTION

A component module according to the invention may be formed in a number of different ways and for different functions and purposes optical as well as other.

In Figs. 1a-1f a component module is described which is formed as a receiver module 10 which will be described layer by layer. In Fig. 1a the top-side or the top-layer 1 of the receiver module 10 with the receiver circuit M is illustrated. This uppermost layer can also be said to form a componentlayer or the component side to which different components, according to the particular embodiment optical components, can be connected. The carrier substrate of the receiver module 10 comprises six layers 1, 2, 3, 4, 5, 6 with so called COB (Chip-On-Board) mounting of the chip. The ship is partilcularly protected by a plastic drop for example of epoxy. The top-layer of metal (for example 100 μm) comprises a number of thermal vias see 31a, (Fig. 3) which go from the top-layer 1 down to the bottom ground layer 6. The component module 10 is made for surface mounting with contacts at the borders. In particular the carrier substrate is very thin, for example merely about1 mm in order to have an as low impedance and high capacitance as possible in the feeding planes. A number of different signals can connect to the chip around its borders. A and K means anode and cathode respectively and this forms the data-entrance whereas DO and NDO respectively comprise data-outputs. In the figure furthermore CO and NCO respectively are indicated comprising clock output. VEE illustrates contact to ground plane or ground layer (not everyone indicated in the figure). The different VCC-planes form different feeding planes. The anode and cathode connections respectively (pads) are intended for mounting for example by soldering of optical components and should therefore not be covered by the plastic drop, i.e. the encapsulation.

All semicircularly shaped recesses 9 in the connection pads around the periphery of the component modules form particularly one half of through via holes which are in connection with all the layers 1-6 in the connections pads wherein the outer half of the via holes is milled off or similar.

Contact between different ground and power feeding planes respectively may be achieved both through the vias of the connection pads as described above and through vias in the planes. As to ground planes, connection can also be achieved through thermal vias.

Fig. 1b illustrates layer 2 which constitutes a ground layer, VEE and which is slightly shaded. This layer 2 lies directly below the toplayer 1, the contact layer or the signal layer. An opening 14 is arranged for reducing capacitive coupling between the top component layer 1 and the ground layer VEE 2. The area of every feeding plane or layer should however be as large as possible in order to get maximum capacitive coupling between the planes or layers. As in the preceding figure A, K constitutes dataentrance, DO, NDO data-exits and CO, NCO clockoutput. The substrate comprises vias 12 whereas so called VCC-vias are arranged in openings 13 which consequently are not in contact with the concerned layer or the layer in question, in this case layer 2. In Fig. 1c the voltage plane or the feeding plane 3 is illustrated, the so called VCCA-layer which is an analogue voltage layer. The opening 14′ in the VCCD-layer is somewhat larger than the VEE-opening 14 in order to ensure that the coupling to the VCCD-plane is much smaller than the coupling to the VEE-plane. In a way analogue to Fig. 1b vias in the openings 13′ are not in connection with the VCC-plane in contrast to vias 12′. Likewise analogue to the former figures 1a and 1b respectively data-entrances and data-exits respectively as well as clock-outputs are illustrated. VCCA-layer 3 gets at connection 15′ contact with the contact layer in a manner similar to that how the ground layer VEE 2 gets contact at the connection pads denoted 15 (not all denoted). In

Fig. 1d is once again illustrated a ground layer 4, VEE, which also is slightly shadowed. In a way analogue to what has been illustrated in the foregoing figures data entrances and data exits respectively and clock-outputs are illustrated and layer 4 gets contact at the connection pads denoted 15''. The opening 14'' is intended to reduce capacitive coupling between the contact layer 6 of the receiver module and the feeding planes 2-6. Circular rings (without surrounding opening) designate vias in contact with layer 4. It is common for each figure that via 12 designates a via in contact with the concerned layer or the layer in question whereas 12' designates a via not in contact with the concerned layer, whereas openings 13 comprises vias 12' which are not in contact with the layer 4 in a way similar to the preceding figures. 15'' illustrates connection pads. In Fig. 1e a layer 5 is shown which is comprised by a feeding layer which comprises the analogue feeding layer VCCA, 5a, and the digital feeding layer VCCD, 5b. Data-in-, data-outputs respectively and clock-outputs are denoted in a manner analogue to the preceding figures. The opening 14''' for the VCCD-plane is somewhat larger than the VEE-opening 14'' in order to ensure that the coupling to the VCCD-plane will be much smaller than the coupling to the VEE-plane or the layer 4 which is a ground layer. The two feeding layers 5a and 5b respectively get in contact with the contact layer 1 at the connection pads 15a'' (respectively) 15b'' and through vias between the respective layers as described above. The layer 6 forming the bottom layer or the contact layer consist of a ground layer (VEE) is illustrated in Fig. 1f. Vias which are not connected to layer 6, the bottom layer, are terminated in layer 5a and 5b respectively (or in previous layers) and constitute so called blind vias. Layer 6, VEE-layer, is large and leads heat down to an external carrier substrate, not shown here. The connection pads 9' in this layer are larger since they connect to the mother card or the external carrier substrate.

In Fig 2a a component module is illustrated which constitutes a transmitter module 2 corresponding to the receiver module

illustrated in Figs. 1a-1f. The toplayer 1' form the topside or the component side and is illustrated shaded. In the middle a transmitter circuit S is arranged. CK and NCK respectively constitute clock-entrances whereas DI and NDI respectively comprise data inputs. K_1, A_1 illustrate data-output whereas K_{pin} and A_{pin} illustrate data-input, wherein L means laser diode L and PIN designates a so called PIN-diode. The reason that a receiver diode is used, a so called PIN-diode, is that it is desired to sense that light the laser diode is emitting. Components may be comprised by resistances, capacitors etc. and the plastic drop or similar is applied thereover to form an encapsulation of the component module. Normally the constitutional components are protected, in the illustrated embodiment the contacts K_1, A_1, K_{pin}, A_{pin} are free as they are in Fig. 4a. The same is true for the embodiment according to Fig. 1a. The figure is otherwise analogue the previous figures concerning the receiver module 10. In Fig. 2b is illustrated, as an example, an intermediate voltage or feeding layer, layer 3', which is formed by VCCD-layer 3a' and VCCM-layer 3b'. Layer 3a' as well as layer 3b' are darkly shaded whereas faint shading illustrates layer 2' which forms a ground layer or a ground plane, VEE. The opening 18 for the VCCD-layer or plane is somewhat larger than the opening 19 for the VEE-plane to ensure that the coupling to the VCCD-plane is essentially smaller than the coupling to the VEE-plane or layer. Furthermore it is illustrated in Fig. 2b that signals also may be drawn in the layers through vias 16 which end in layer 3'.

The other layers of the transmitter module 20 are not shown but the construction is similar to that which has been described under reference to the receiver module 10.

In Fig. 3 an example of a component module is schematically illustrated which is based on a so called multi-layer structure. The general appearance of the involved layers is of course also valid for the transceiver modules which will be described in the following. In the present case there are eight layers, the toplayer constituting a so called signal layer or

a component layer after which follows a number of feeding layers, ground layers, VEE-alternating with power supply layers, VCC down to the undermost ground layer, VEE which at the same time forms contact layer to an external carrier substrate or a printed board, not shown. In the figure faint shading illustrates VCC-planes whereas the darker shading illustrates VEE-planes. Through the planes are arranged so called thermal vias 31a for dissipation of heat and electrical coupling between the planes. The other vias 30a are arranged as blind vias or concealed or buried vias. The IC-circuit is connected to the component layer via bonding filaments 33a. The isolation layers 32a are arranged between the different feeding layers. In the figure C, denotes capacitors which are arranged on the component layer; other components are of course also possible such as inductors etc. The thin isolation layers 32a may for example consist of plastic laminate or glass fibre laminate. The different signals are mainly present in the top, so called signal layer or the component layer, but may, as shown above, also be present in intermediate layers. As an alternative to, for example a surface mounted LCC or a PAA-formate of the component modules, an embodiment with pins or leads for hole mounting is also possible wherein pins (leads) are mounted along one or more sides of the component module.

According to a particular embodiment of the invention a so called transceiver or a transceiver module 50a is formed which comprises different units or component modules such as a receiver module 10a, a transmitter module 20a and a wavelength division multiplexor unit 25a. Generally may even the transceiver be said to itself constitute a component module. This embodiment is described i Fig. 4a which shows a view from above of the transceiver 50a whereas in Fig. 4b the transceiver module 50a is seen from the side. Therein 501a illustrates threads for fibre optical contact whereas 502 illustrates a hole for fibre optical contact a so called receptavle connection. Receiver module as well as the transmitter module are covered by a plastic encapsulated, for example in the form of a plastic drop 503a. Transmitter module 20a as well as

receiver module 10a are mounted on a carrier substrate 500a. Generally the three sub-modules forming components modules, the receiver module 10a, the transmitter module 20a and the wavelength division multiplexor unit 25a respectively can be mounted either onto an internal carrier substrate or directly onto to an external carrier substrate, (the PCB-substrate), not shown. In the embodiment shown in Fig. 4a the transmitter module 20a is mounted on top of the carrier substrate 500a whereas the receiver module 10a is mounted under the carrier substrate 500a. An opening 504a is arranged in the plastic drop or the plastic cover 503a which enables the forming of so called connection pads on the module. In the figure the circuit is denoted 510a. In Figs. 4a and 4b respectively is furthermore illustrated how transmitter diode 511a, which comprises a laser diode LD or a light emitting diode, LED, and furthermore also includes a so called monitoring diode, a PIN-diode which performs a control function and a receiver diode 512a (PIN) which are connected via connection leads 513a and 514a respectively through which they are connected directly down to the transmitter module 20a and the receiver module 10a respectively, particularly on the top-side of those. The transmitter and the receiver diodes 511a and 512b respectively included in the so called wavelength division multiplexor unit which at least as far as signals are concerned is directly connected to the transmitter and the transceiver modules 510a and 511a respectively. The connection leads 508a are according to a particular embodiment soldered onto the component module (or COB-module) or the transceiver module 50a.

According to particular embodiments transmitter and receiver modules are formed corresponding to the transceiver modules 50a; 50b; 50c, i.e. the transmitter module comprising the transmitter module and components and circuits necessary for a transmitter but whereinthe receiver module etc. are omitted and which otherwise is similar to the modules as illustrated in Fig.s 4,; 4b; 5a; 5; 6. In the case of receiver module instead the component circuits and so on relating to a transmitter are omitted. Although these emobidments are not shown it is believed to be clear how it works.

In Figs. 5a and 5b respectively illustrate an alternate transceiver module 50b (also this could be a transmiiter module or a receiver module, see above) is illustrated comprising a receiver module 10b arranged under the carrier substrate 500b and a transmitter module 20b arranged above the carrier substrate 500b. In a way analogue to that described in Figs. 4a and 4b respectively receiver module 10b as well as transmitter module 20b are covered by a plastic cover or the plastic drop 503b which comprises an opening 504b in order to form contact islands. Likewise in an analogue way to what has been described in Figs. 4a and 4b respectively the receiver diode 512b (PIN) is via connection leads 514b connected to the receiver module 10b whereas the transmitter diode 511b is connected to the transmitter module 20b via connection leads 513b. Even in this case the transmitter diode 511b conveniently comprises an LD or an LED and at the same time including a monitoring diode of PIN-type to carry out the control function as mentioned above. The connection leads 508b form connection to an external carrier substrate or a printed board (not shown). In the shown embodiment a so called Pig tail connection 501b is utilized. In both these cases transmitter module and receiver module are arranged on either side of some kind of a carrier substrate, either essentially one module right opposite to the other or both in a distance from each other. According to a further embodiment, which is schematically described in Fig. 6, transmitter module 20c and receiver module 10c could be arranged on the same side or a carrier substrate 500c. In this case the wavelength division multiplexor unit 25c has to be rotated about 90° around the fibre axis. In other respects the figure is analogue to the preceding figures, i.e. connection leads 513c, 514c between transmitter and receiver modules 20c, 10c respectively and transmitter and receiver diodes 511c and 512c respectively; transmitter circuit 510c, receiver circuit 510c′ etc., see also the embodiments relating to separate transmitter and receiver modules as described above.

According to further alternate embodiments opto-components may be mounted directly on top of the component modules. An

optofibre may than be connected to the opto-component through a small contact. This is schematically illustrated in Figs. 7a and 7b respectively. In Fig. 7a particularly a transmitter module 70 is illustrated which forms a so called COB-module mounted on PCB which may be comprised by a conventional six or eight layer substrate with Chip On Board mounting of the chip. The component module is protected by a plastic drop, particularly exopy, not shown in the figure. The component module is fabricated for surface mounting and comprises contacts 79 on the borders.

The transmitter module comprises a transmitter circuit 71 and a directly mounted so called MT-connector or a MT-device 72 comprising a light emitting diode or a laser diode (LED or LD), not shown. The MT-device may according to different embodument comprise a WDM or not. In Fig. 7b a receiver module 80 is shown corresponding to the transmitter module 70 in Fig 7a. The carrier substrate (PCB) comprises a conventional six or eight layers substrate (of course also other embodiments are possible) wherein the chip is mounted by so called COB-mounting wherein furthermore the receiver module 80, i.e. the chip and components belonging thereto are protected by a plastic drop or epoxy. Similar to Fig. 7a the receiver module 80 is intended for surface mounting and comprises contacts 89 along the sides. The surface mounted, or directly mounted, MT-connector or the MT-device 82 comprises in this particular embodiment a PIN-diode, furthermore a receiver crystal 83 is integrated on the module. A component module may particularly comprise a number of (an array) of receiver and transmitter devices respectively, each preferably connected to a separate fibre. Even more particular the so called MT-device 72; 82 may comprise a number of transmitter and receiver devices respectively in agreement with the above mentioned.
A further example of a component module is shown i Figs. 8a and 8b respectively which illustrate a non-optical application of the component module concept, this of course merely being an example, a number of other applications, optical as well as non-optical being possible. At the component module 90, which

may be called an integrated component type, components are integrated or embedded in the carrier substrate 95. As in a number of the in the foregoing illustrated component modules the carrier substrate may comprise a conventional six or eight layer substrate wherein the circuit is mounted by COB-technique whereafter the component module, i.e. circuit 98 and components are protected by a plastic drop or epoxy. The component 90 is intended for surface mounting and comprises contacts 99 along its sides. The circuit 98 constitutes together with a surface wave filter 92 (SAW, Surface Acoustic Wave) an oscillator mounted on top of or surface embedded in the component module 90 and compensation inductors 93 are integrated and mounted in the carrier substrate 95 within the module. The inductors 93 are so called thoroidal coils, these are protected by outer layers of the carrier substrate 95. These coils 93 are thus fabricated directly in the circuitry pattern. In Fig. 8b is illustrated a cross-section of one of the inductors 93 with eight turns made by two inner layers of the carrier substrate wherein the two layers surrounding the inductor 93 have different patterns and are connected through the vias 97. The vias 97′ in the centre provide the connection to the signal layer which is situated on the top. According to a embodiment (not shown) the thoroid(s) is(are) constituted by bonding filaments and substrate pattern which thus forms a surface mounting. Therethrough it is possible to obtain more turns and the thoroid/the inductor is particularly made at the same time as the circuit is connected through bonding technique.
Thoroids constitute a further example of surface mounted components as described above.

Above optical as well as non-optical applications have been dealt with. In both cases components, optical or not, may be connected in a direct way onto a component module or be mounted directly thereon. Through the invention the prevailing conventional concept capsule/component is extended since a component module comprises a carrier substrate, card or printed board as well as components and circuit or circuits. According to the COB-technique the circuits are mounted directly onto the

carrier substrate or printed board without any encapsulation into an advanced module with thin leads, wherein ground and feeding planes may be arranged in several layers on top of each other with very small components and surrounding components respectively and with at least one integrated circuit whereafter all of it except from possible contact areas are covered by a protection material or particularly a plastic drop. Particularly convenient is of course that if the component module (or the transceiver module) externally is of a standard formate as a standard capsule. It the components which for example may be mounted on top of a component module can be made even smaller, the electrical properties will further improve. Instead of bonding the circuits to the carrier substrate it is possible to use so called flip-chip technique. By using this mounting method it is possible to further reduce the size of component module since this technique does not require any space outside the circuit for the electrical connections, i.e. what in the foregoing has been denoted connecting pad. The size of the component module may reach some square centimeter or more, but also less. E.g. a transmitter or a receiver module may have a size of 0,5 x 0,5 or bigger whereas a transceiver diode may have a size of 5-8 mm, but this is only given as exemples. E.g. transceiver according to the emboudment with an MT-device may be smaller and habe a size of about 2-4 cm^2 but this is also merely as example the size of course being related to the performance, functionality and so on.

Referring to the receiver modules 50a; 50b the optical components, i.e. transmitter diode 511a; 511b (LD or LED) and receiver diode (PIN) 512a; 512b are hermetically encapsulated in each a standard TO-18-capsule according to a particular embodiment. Through the doublesided mounting of the transceiver modules 50a; 50b the mounting of the wave-length division multiplexer unit 25a; 25b is facilitated. With the transceiver modules 50; 50b the wavelength division multiplexor units 25a; 25b are so mounted that the laterally arranged receiver diode goes down through a hole in the carrier substrate 500a; 500b of

the transceiver module, said carrier substrate 500a, 500b comprising signal lead planes on the outer sides and feeding planes and ground planes respectively therebetween as a shield between transmitter side and receiver side. Therethrough an electrical shielding is obtained between receiver and transmitter. The mounting of the transceiver module 50a; 50b on an external board (not shown) gives a complete shielding of the receiver side since the shielding from the top side of the transceiver module and its connection leads 508a; 508b on the sides and underlying ground planes in the external board onto which the transceiver module 50a; 50b is mounted. The mounting of the optical components then takes place directly onto the transmitter modules 20a; 20b and the receiver modules 10a; 10b respectively and consequently not via the carrier substrate 500a, 500b respectively of the transceiver 50a.

According to an alternate embodiment (not shown) it is also possible to mount transmitter module as well as receiver module and wavelength division multiplexor unit directly onto an external card, i.e. the carrier substrate of the transceiver is not used for this purpose. Analogue to the above also transmitter module and receiver module are in this case mounted on each one side of the external carrier substrate. Also in this case a good shielding is obtained between transmitter and receiver since the ground plane between those two is large and extended. According to a further embodiment a number of transmitter modules and receiver modules and WDM may be mounted on an external carrier substrate. According to the embodiment described in Fig. 6 the transmitter module 20c and the receiver module 20c are mounted onto the same side of the transceiver carrier substrate 500c through the wavelength division multiplexor unit 25c being rotated a quarter of a turn around the fibre axis so that the receiver diode 512c will be arranged on the same side of the transceiver carrier substrate 500c as the transmitter module 20c and the receiver module 10c. Analogue to Figs 4a, 4b; 5a, 5b transmitter diode 511c and connection leads 513c and 514c are connected to transmitter, and receiver module 20c, 10c. In Fig. 6 the circuits 510c,

510c' are schematically indicated. With this plane construction direct mounting onto an external card without the transceiver carrier substrate 500c would also be possible. This is also general, i.e. that a number of transmitter modules and receiver modules and wavelength demultiplexor units could be arranged on one common carrier substrate, i.e. also without any so called planar mounting.

According to a further alternate embodiment (not shown) it is possible to, instead of a WDM unit utilize two fibres, each for one direction where even more particular a number of fibres in each direction one or more transmitter modules being arranged on one side of the transceiver carrier substrate and one or more receiver modules being arranged on the opposite side of the transceiver carrier substrate. According to a further alternative it would be possible to use unidirectional links with transmitter modules on both sides of the transceiver carrier substrate and receiver modules on both sides in the receiving end respectively and a WDM unit for unidirectional traffic respectively.

According to different embodiments it is possible to connect an array of lasers to a WDM or a WDM to an array of lasers.

If further shielding would be required all around the module separate shielding may be applied for receiver and transmitter side respectively.

The transceiver 50a, 50b illustrated in Figs. 4a and b and Figs. 5a and 5b respectively is according to a particular embodiment intended for two-directional transmission with different wavelengths on a common fibre (1300 nm and 1550 nm respectively) for different speeds from 155 Mbit/s to about 800 Mbit/s. The transmitter module then comprises among others an electrical modulator for the laser diode, control circuits to control the modulation, control circuits etc. whereas the receiver module among others comprises amplifier, decision circuit, clock recovery. It is possible to add MUX/DEMUX-

circuits to the transmitter module and the receiver module respectively in a very small space as it is possible to utilize carrier substrates of flex-foil or low-loss substrates such as teflon. To sum up the component module according to the invention extends the component concept since it constitutes a capsule for circuits as well as it comprises desired surrounding and additional components, wherein the module per se also may comprise passive components which are integrated directly on the card such as for example small capacitors or inductors.

Generally, according to particular embodiments, it is possible to instead od connecting one fibre with each a PIN-receiver arrange a WDM inbetween.

The invention is of course not limited to the described embodiments but may be freely varied within the scope of the claims.

Claims

1. Component module (10; 20; 30; 50a; 50b; 50c; 70; 80; 90) comprising at least one carrier substrate which may be internal or external, at least one circuit with at least to the circuit belonging components or to the circuit belonging components as well as additional components, wherein the circuit(s) is/are directly mounted onto the carrier substrate, and the component module (10; 20; 30; 50a; 50b; 50c; 70; 80; 90) comprises an enclosing device, c h a r a c t e r i z e d in that the enclosing device at least in one direction encapsulates essentially the major part of the component module (...) and in that the component module (10; 20; 30; 50a; 50b; 50; 70; 80; 90) is so formed, preferably externally in the form of a standard circuit that it can be directly mounted onto an external carrier substrate, card or a printed circuit board and in that the carrier substrate comprises a small printed circuit board made of plastic, glass fibre laminate, epoxy or silicon or similar or a multilayer ceramic.

2. Component module (10; 20; 30; 50a; 50b; 50c; 70; 80; 90) according to claim 1, c h a r a c t e r i z e d in that it further comprises independent components.

3. Component module (10; 20; 30; 50a; 50b; 50c; 70; 80; 90) according to claim 2, c h a r a c t e r i z e d in that at least one of the independent components per se constitutes a component module.

4. Component module (10; ...; 90) according to claim 1, c h a r a c t e r i z e d in that it externally is formed as a lead-less standard circuit such as for example an LCC-standard circuit or a PAA-standard circuit.

5. Component module (10; 20; 30; 50a; 50b; 50c; 70; 80; 90) according to claim 1, c h a r a c - t e r i z e d in that it comprises leads or pins along at least one of its sides, in one or several rows.

6. Component module (10; ...; 90) according to claim 1, c h a r a c t e r i z e d in that the enclosing device comprises a plastic drop.

7. Component module (10; ...; 90) according to claim 1, c h a r a c t e r i z e d in that the enclosing device comprises a silicon drop.

8. Component module (10; ...; 90) according to anyone of the preceding claims, c h a r a c t e r i z e d in that the carrier substrate comprises at least one signal layer or component layer (1; 1'), a contact layer (6) and a feeding layer (2, 3, 4, 5, 6; 3'), isolation material being arranged between the different layers.

9. Component module (10; ...; 90) according to claim 8, c h a r a c t e r i z e d in that the isolation material comprises plastic laminate, glass fibre laminate or similar for example arranged in the form of thin isolation layers (32a).

10. Component module (10; ...; 90) according to claim 8, c h a r a c t e r i z e d in that the carrier substrate comprises a number of feeding layers (1, 2, 3, 4, 5, 6; 1', ..., 3', ..).

11. Component module (10; ...; 90) according to claim 8, c h a r a c t e r i z e d in that at least some of the vias (12, 12'; 30, 31a; 97, 97') arranged in the carrier substrate are buried or blind.

12. Component module (10; ...; 90) according to claim 8, c h a r a c t e r i z e d in that thermal vias (31a) are arranged for heat dissipation from circuits etc.

13. Component module (10; ...; 90) according to anyone of the preceding claims, c h a r a c t e r i z e d in that the circuits are mounted on and connected to the carrier substrate either via bonding technique or via so called flip-chip-technique.

14. Component module (10; ...; 90) according to anyone of the preceding claims, c h a r a c t e r i z e d in that it is an optical module.

15. Component module according to anyone of the preceding claims, c h a r a c t e r i z e d in that at least one of the circuits is a transmitter circuit (S, 510a; 510b, 510c; 71) to which components is arranged, an optical block comprising a transmitter device further being connected to the carrier substrate and in that the component module forms a transmitter module (20a; 20b; 20c; 70).

16. Component module according to claim 15, c h a r a c t e r i z e d in that the transmitter device comprises a transmitter diode (511a; 511b; 511c) such as for example an LD or a LED.

17. Component module according to claim 15, c h a r a c t e r i z e d in that the transmitter device is comprised by a wavelength division multiplexor unit which among others further comprises a wavelength filter and optical connection means.

18. Component module (70) according to claim 15, c h a r a c t e r i z e d in that the optical block comprises at least one transmitter device comprising MT-means (72).

19. Component module according to claim 15, c h a r a c t e r i z e d in that it comprises a number of (an array of) transmitter devices each preferably connected to a separate fibre.

20. Component module according to anyone of claims 18-21, c h a r a c t e r i z e d in that the optical block either as a whole or in the form of separate parts is directly mounted onto the carrier substrate.

21. Component module according to anyone of the claims 1-14, c h a r a c t e r i z e d in that at least on of the circuits is a receiver circuit (M; 510c′; 81) to which components are arranged, an optical block comprising a receiving device furthermore being connected to the carrier substrate so that the component module forms a receiver module (10a; 10b; 10c; 80).

22. Component module according to claim 21, c h a r a c t e r i z e d in that the receiver device comprises a receiver diode (513a; 513b; 513c), for example a PIN-diode.

23. Component module according to claim 21, c h a r a c t e r i z e d in that the receiver device is comprised by a wavelength division multiplexor unit which furthermore among others comprises wavelength filter and optical connections means.

24. Component module according to claim 21, c h a r a c t e r i z e d in that the optical block comprises at least one receiver device comprising MT-means (82).

25. Component module according to claim 21, c h a r a c t e r i z e d in that it comprises a number of (an array of) receiver devices each preferably connected to a separate fiber.

26. Component module according to anyone of claims 21-27, c h a r a c t e r i z e d in that the optical block either as a whole or in the form of separate parts is directly connected to the carrier substrate.

27. Component module accordingto claims 15 and 21, c h a r a c t e r i z e d in that it form a transceiver module.

28. Transceiver module (50a; 50b; 50c) comprising at least one internal or external carrier substrate (500a; 500b; 500c), a transmitter unit and a receiver unit and an optical unit and furthermore connection means (508a; 508b; 508c) for connection to an external carrier substrate, c h a r a c - t e r i z e d in that the transmitter unit and the receiver unit comprises a transmitter module (20a; 20b; 20c) and a receiver module (10a; 10b; 10c) respectivey which are enclosed and mountable on the carrier substrate 500a; 500b; 500c), the optical unit comprising a mountable transmitter and a mountable receiver device.

29. Transceiver module (50a; 50b; 50c) according to claim 28, c h a r a c t e r i z e d in that it externally has the form and appearance corresponding to a standard circuit, for example an LCC-circuit or a PAA-circuit.

30. Transceiver module (50a; 50b; 50c) according to claim 28 or 29, c h a r a c t e r i z e d in that the transmitter unit comprises a transmitter module according to anyone of the claims 15-17 and in that the receiver unit comprises a receiver module according to anyone of claims 21-23.

31. Transceiver module according to claims 28 or 29, c h a r a c t e r i z e d in that the transmitter unit comprises a transmitter module according to anyone of claims 18-20 and in that the receiver unit comprises a receiver module according to anyone of claims 24-26.

32. Transceiver module according to claim 28, c h a r a c t e r i z e d in that the transmitter module (20a; 20b) and the receiver module (10a; 10b; 10c) are arranged on opposite sides of the internal transceiver carrier substrate (500a; 500b).

33. Transceiver module according to claim 28, c h a r a c t e r i z e d in that the transmitter module (20a; 20b; 20c) and the receiver module (10a; 10b; 10c) are arranged on opposite sides of the external transceiver carrier substrate.

34. Transceiver module according to claim 28, c h a r a c t e r i z e d in that the receiver module (10a; 10b) is arranged under the transmitter module (20a; 20b) so that they are shielded from each other by the carrier substrate (500a; 500b) of the transceiver module and/or the external carrier substrate.

35. Transceiver module according to claim 28, c h a r a c t e r i z e d in that transmitter module (20c) and receiver module (10c) are arranged on the same side of the internal (500c) or external transceiver carrier substrate.

36. Transceiver module according to claim 28, c h a r a c t e r i z e d in that the transmitter module (20a; 20b; 20c) as well as the receiver module (10a; 10b; 10c) are directly mounted on the internal carrier substrate (500a; 500b; 500c) of the transceiver module, the signals of the the optical block a wavelength division multiplexor unit (WDM) (25a; 25b; 25c) being in diretct connection with the transmitter and the receiver module respectively.

37. Transceiver module according to claim 28, c h a r a c t e r i z e d in that transmitter and receiver devices respectively are directly connected to the submodules forming component modules i.e. receiver module (10a; 10b; 10c) and transmitter module (20a; 20b; 20c).

38. Transceiver module according to claim 28, c h a r a c t e r i z e d in that connection means to an external and/or internal printed circuit board comprise so called connection leads (508a; 508b; 508c) being arranged along at least one of the outer sides of the transceiver carrier substrate and/or the component module.

39. Transceiver module according to claim 28, c h a r a c t e r i z e d in that the transmitter module (20a; 20b; 20c) and the receiver module (10a; 10b; 10c) each are provided with a protection device (503a; 503b; 503c) in form of a protecting layer of similar.

40. Transceiver module according to claim 39, c h a r a c t e r i z e d in that the protection layer comprises a plastic material, silicon or similar.

41. Transceiver module according to anyone of claims 28-40, c h a r a c t e r i z e d in that the transmitter diode(s) (511a; 511b; 511c) and receiver diode(s) (513a; 513b; 513c) forming a transmitter and a receiver device respectively comprise standard encapsulated diodes, for example TO-18-capsules, preferably directly mounted onto the transmitter and the receiver component modules respectively.

42. Component module (90) according to anyone of claims 1-14, c h a r a c t e r i z e d in that the circuit (98) comprises an oscillator (91) and in that at least some component comprises an inductor (93) either integrated and/or embedded in the carrier substrate (95) or a thoroid comprised by bonding filaments and a substrate pattern.

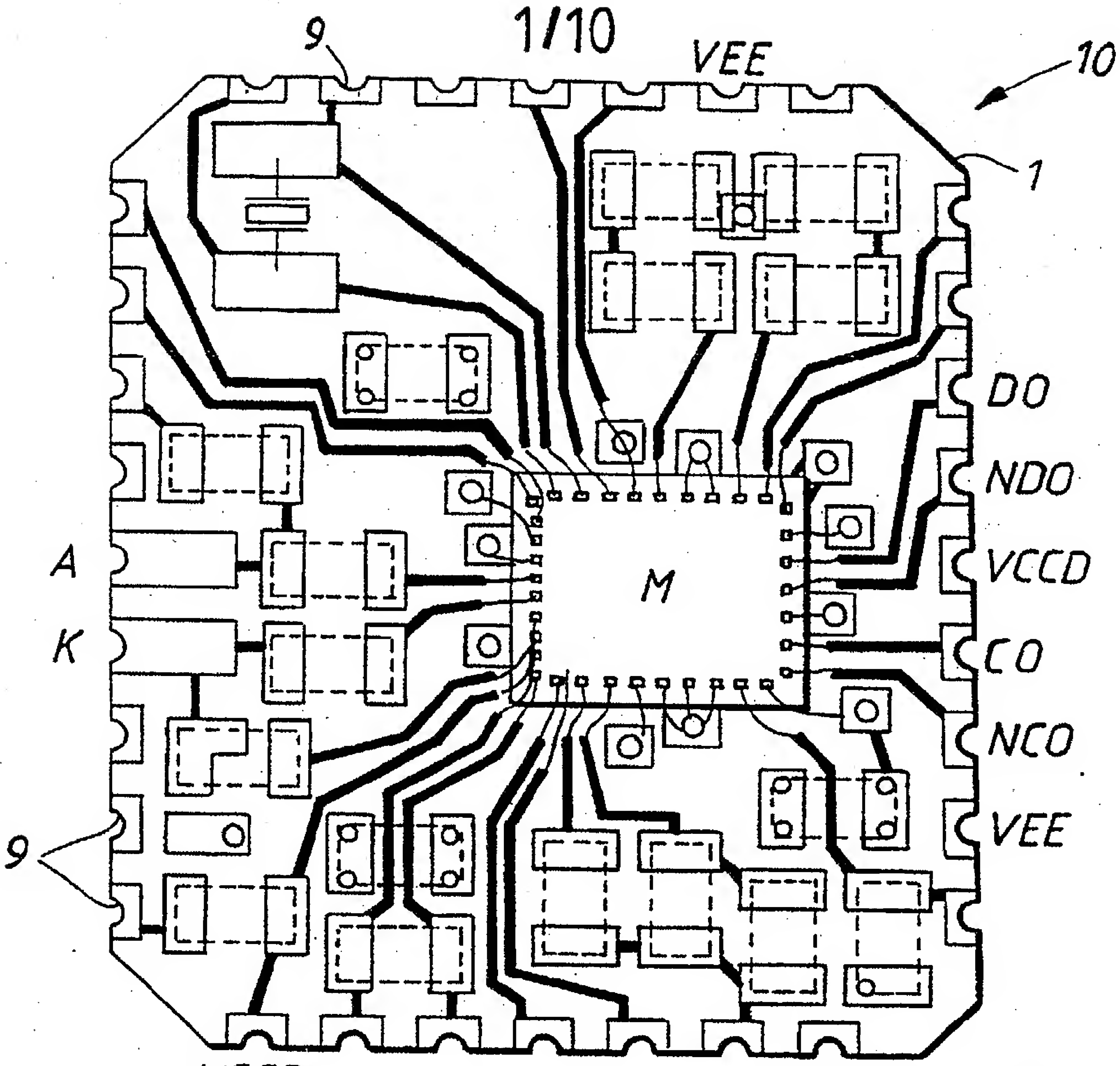

9
VEE
10
1
DO
NDO
VCCD
CO
NCO
VEE
A
K
M
9
VCCP
VEE

FIG.1a

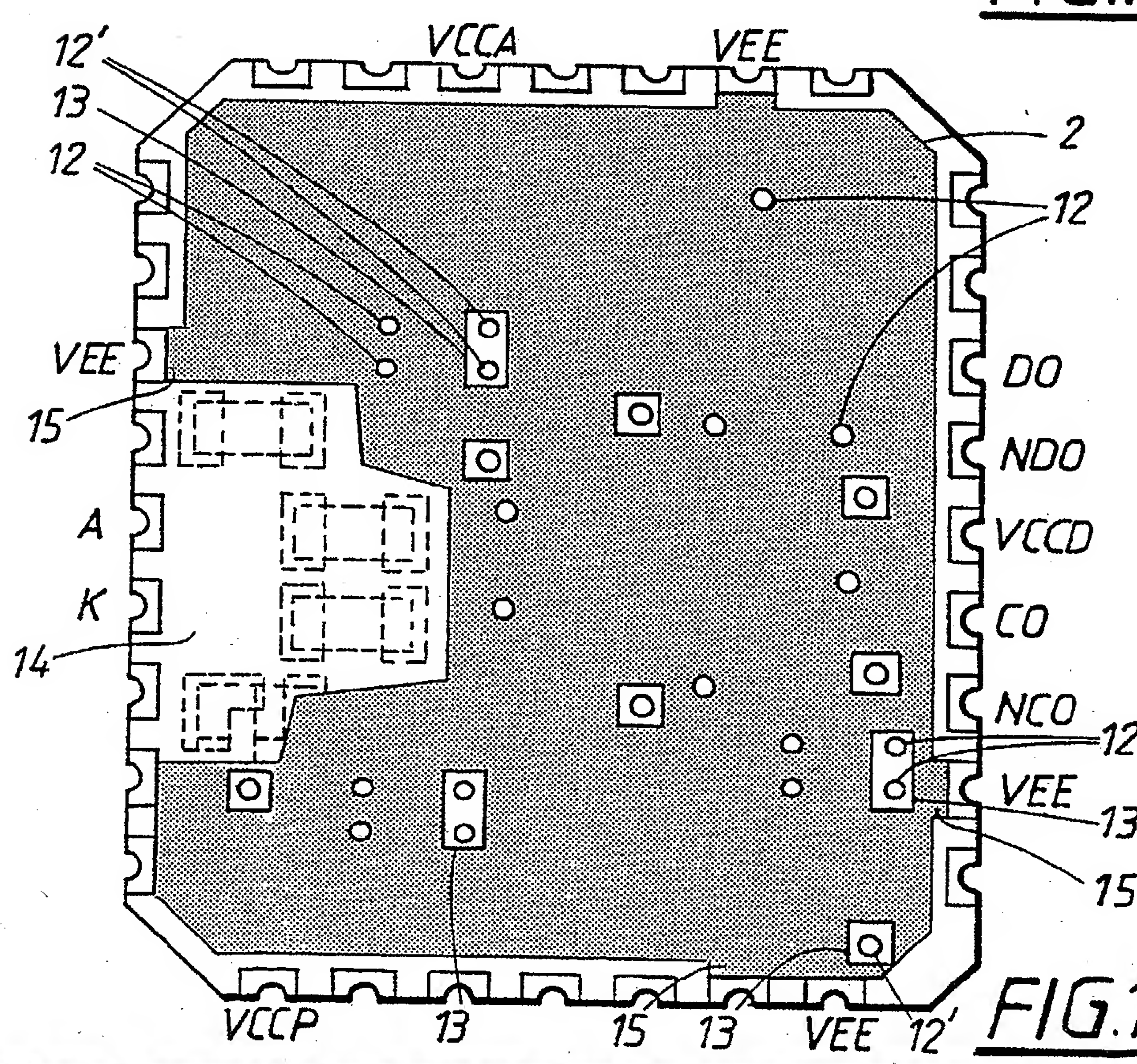

VCCA
VEE
12'
13
12
2
12
VEE
DO
15
NDO
A
VCCD
K
CO
14
NCO
12'
VEE
13
15
VCCP
13
15
13
VEE
12'

FIG.1b

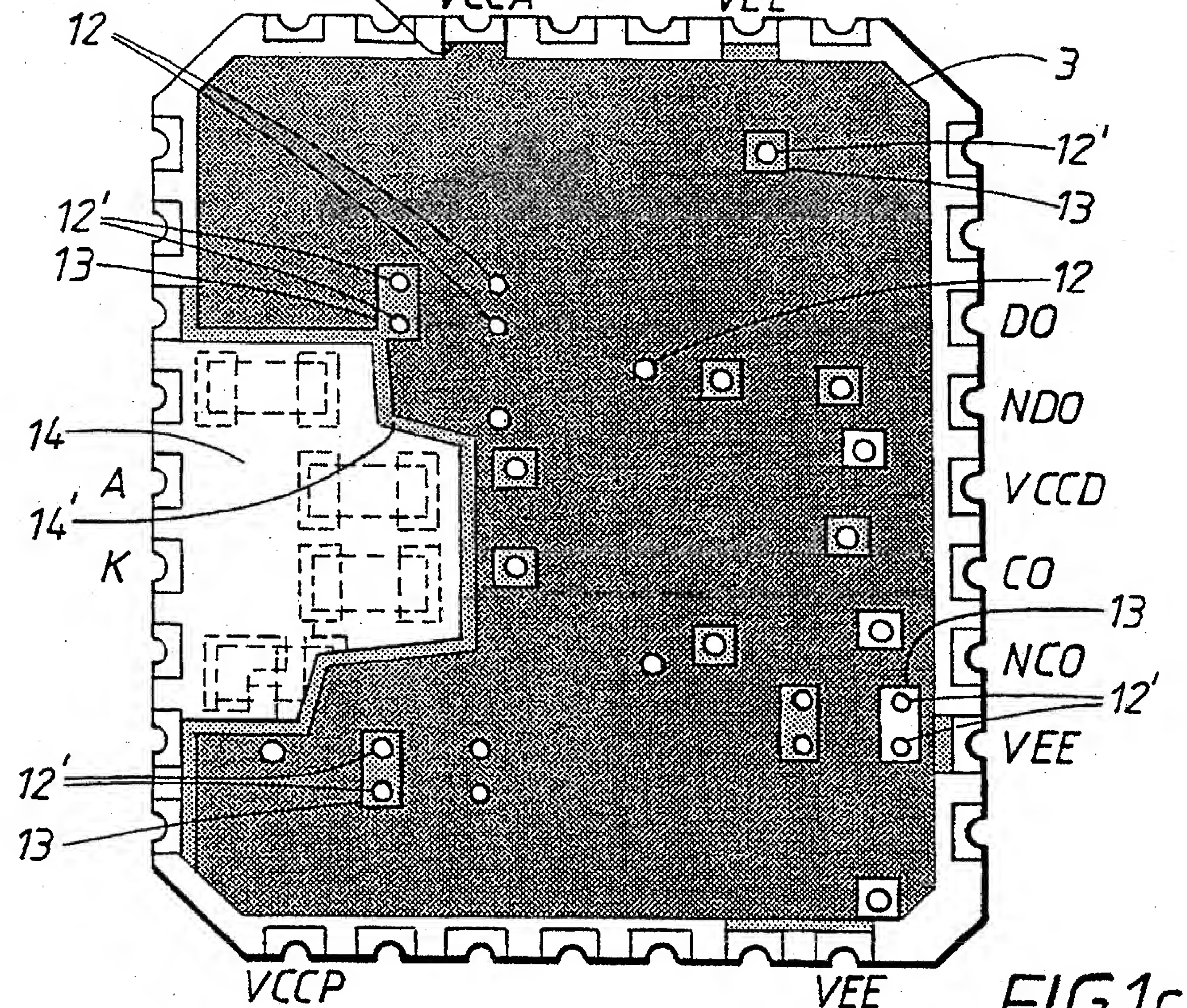

15
VCCA
VEE
3
12
12'
13
12'
13
12
DO
NDO
14
A
VCCD
14'
K
CO
13
NCO
12'
VEE
12'
13
VCCP
VEE

FIG.1c

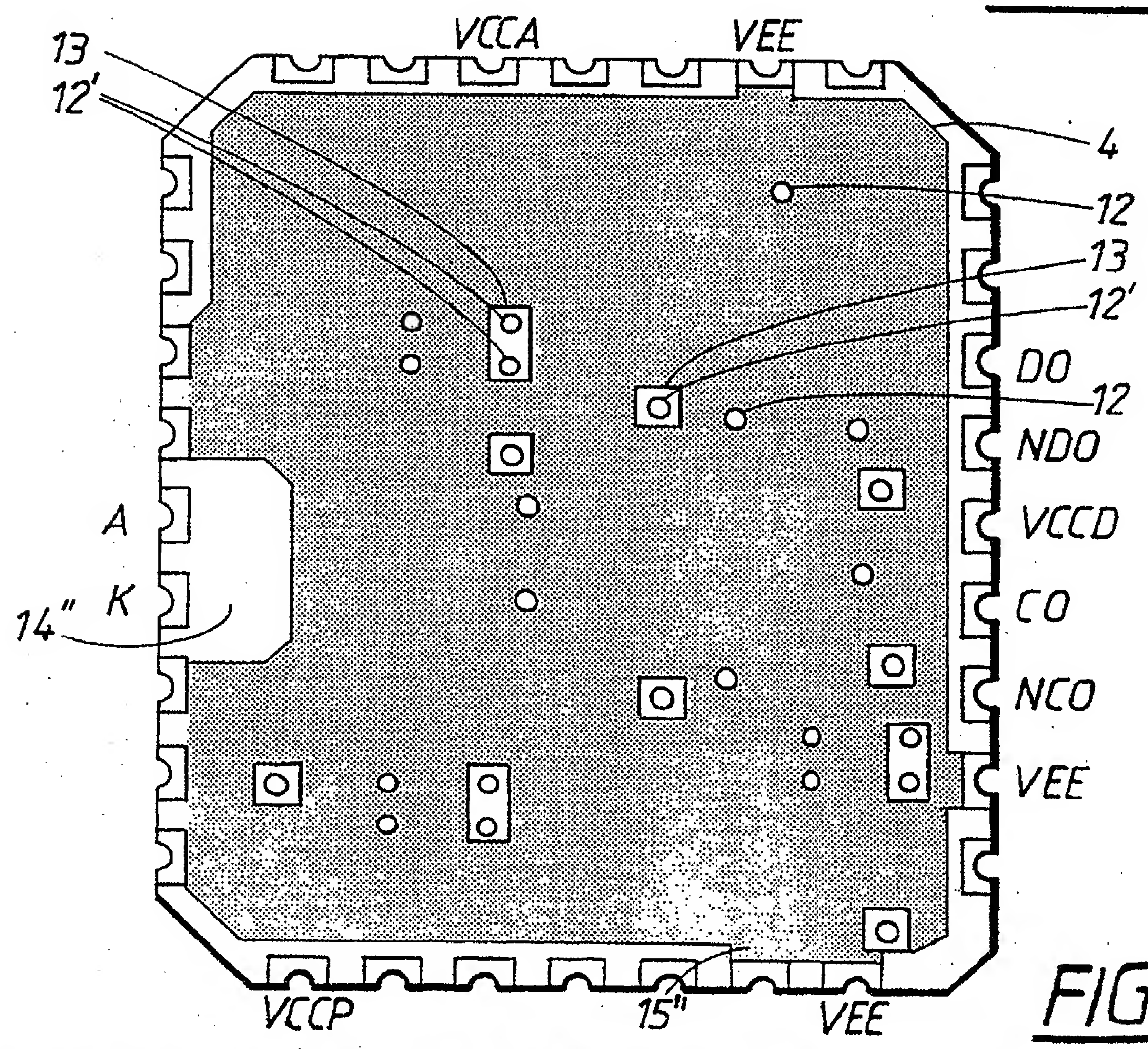

VCCA
VEE
13
12'
4
12
13
12'
DO
12
NDO
A
VCCD
K
14"
CO
NCO
VEE
VCCP
15"
VEE

FIG.1d

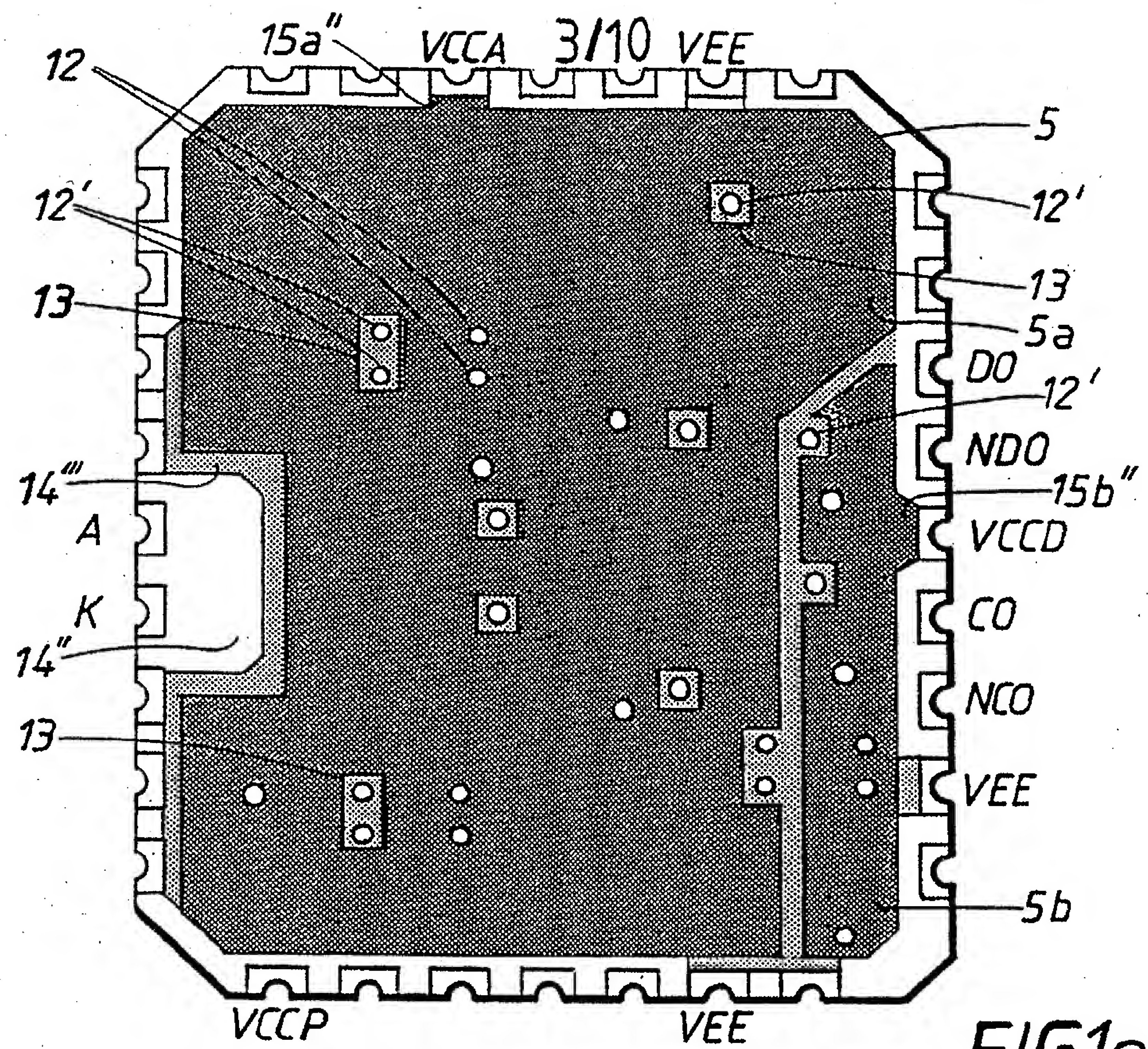

15a"
VCCA
VEE
12
5
12'
12'
13
13
5a
DO
12'
NDO
14'''
15b"
A
VCCD
K
CO
14"
NCO
13
VEE
5b
VCCP
VEE

FIG.1e

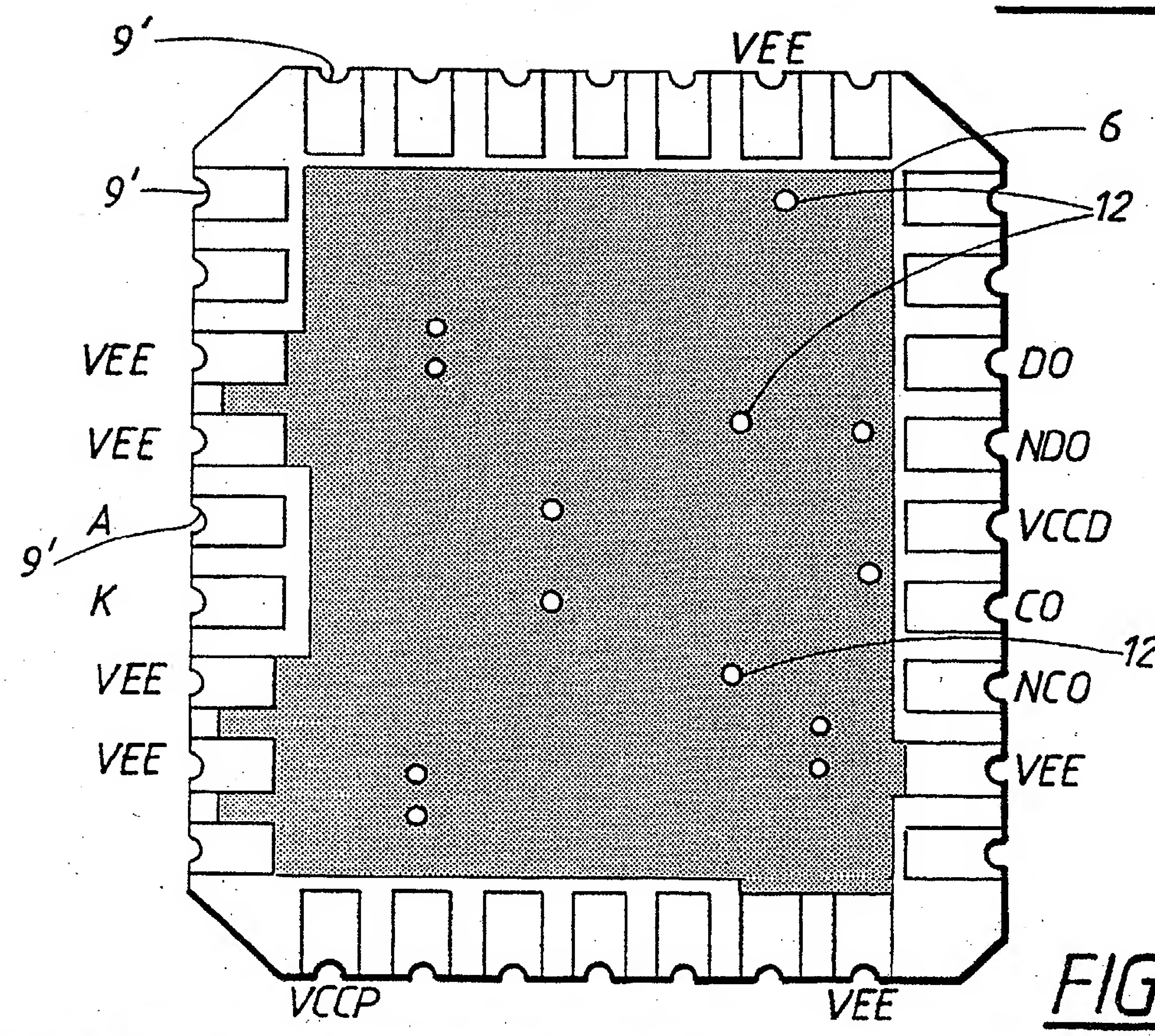
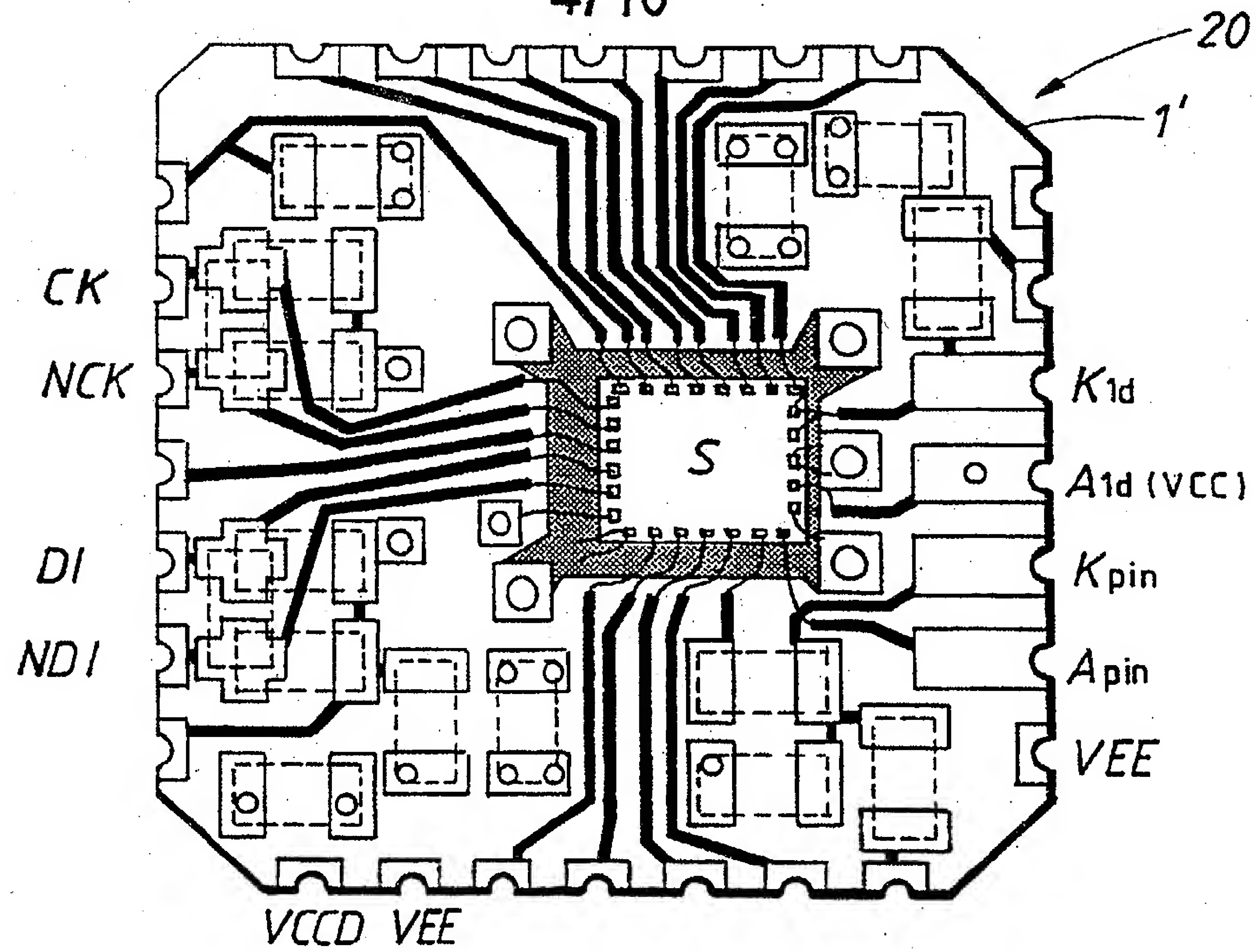
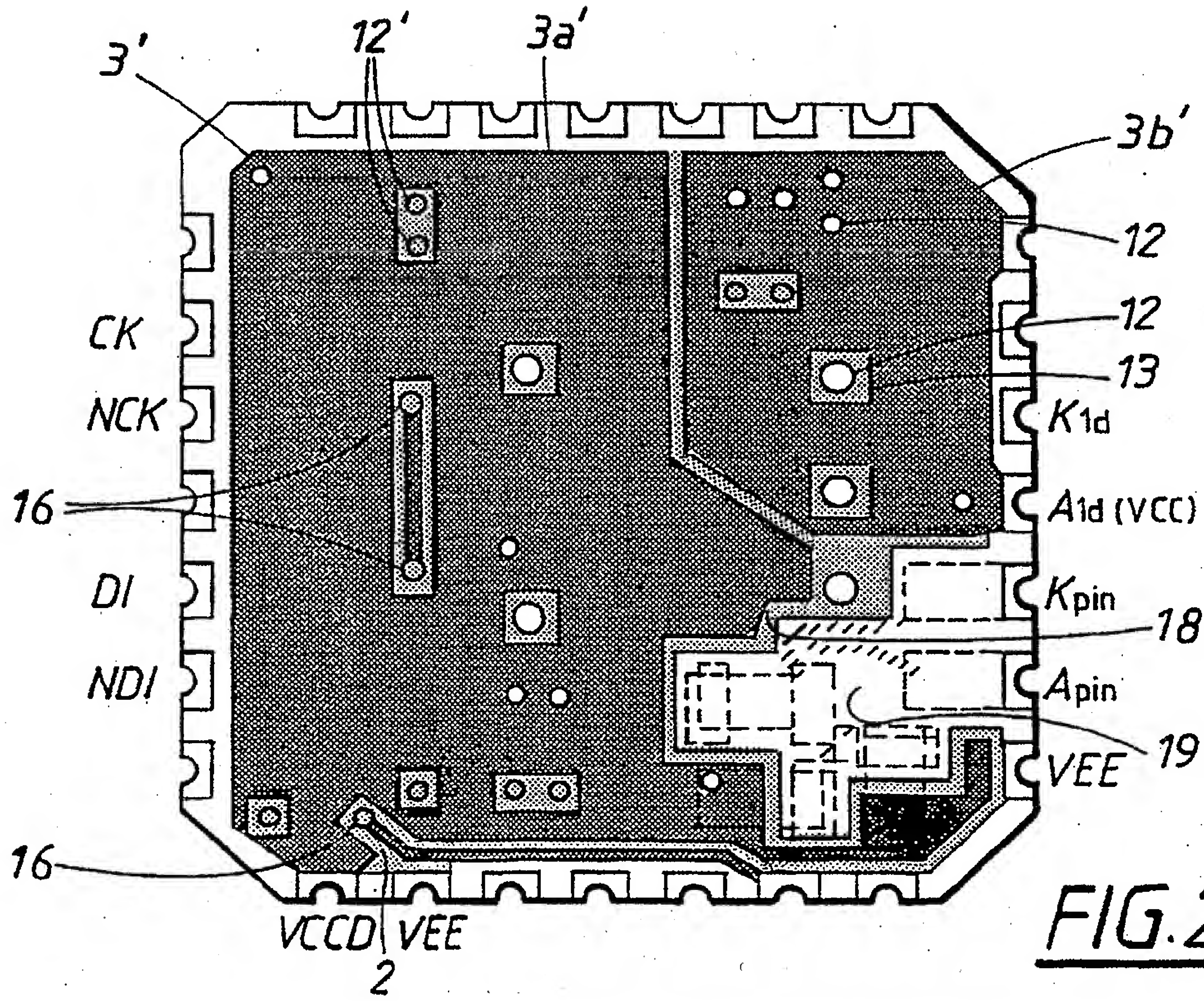

9'
VEE
6
9'
12
VEE
DO
VEE
NDO
A
VCCD
9'
K
CO
VEE
12
NCO
VEE
VEE
VCCP
VEE

FIG.1f



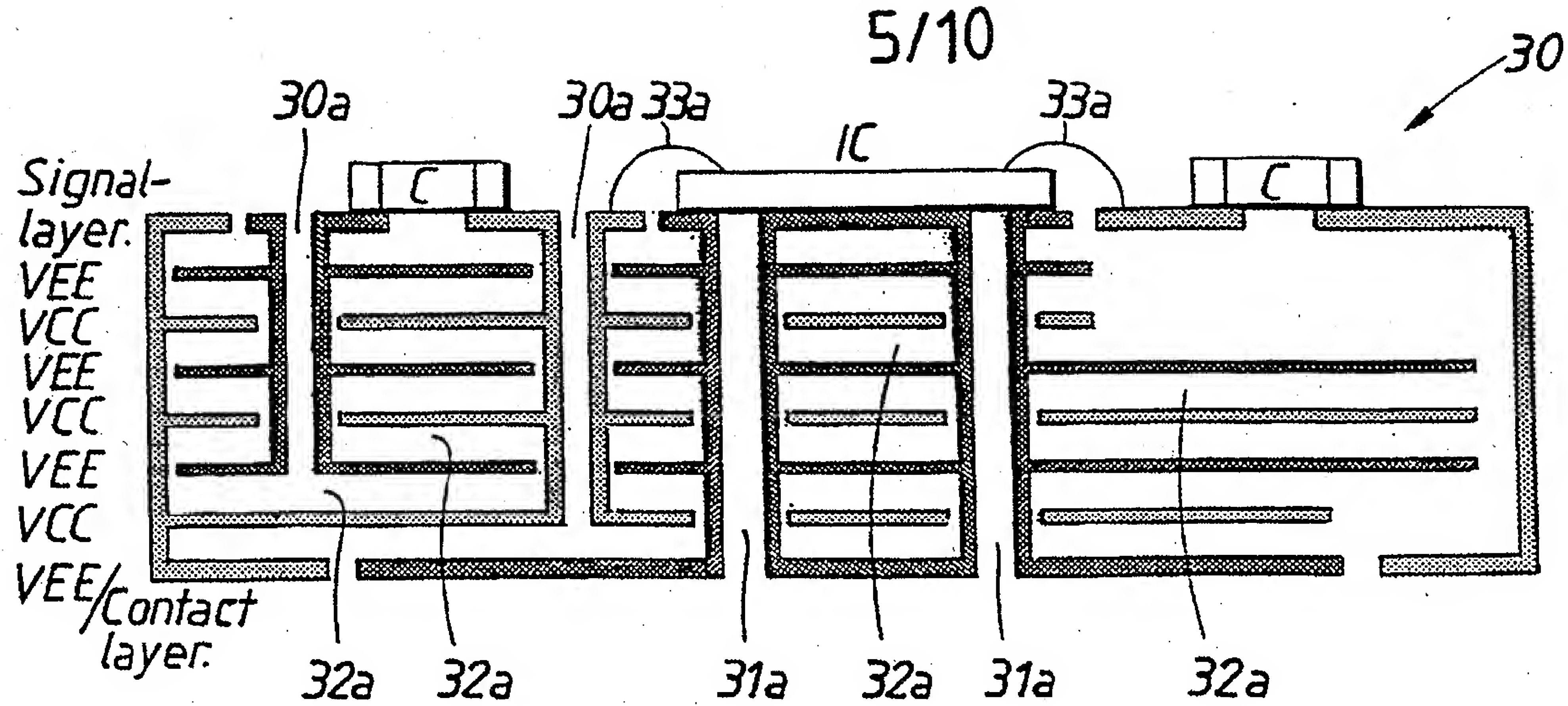
20
1'
CK
NCK
DI
NDI
S
K_{1d}
A_{1d} (VCC)
K_{pin}
A_{pin}
VEE
VCCD VEE

FIG.2a



3'
12'
3a'
3b'
12
12
13
CK
NCK
16
DI
NDI
K_{1d}
A_{1d} (VCC)
K_{pin}
18
A_{pin}
19
VEE
16
VCCD VEE
2

FIG.2b



30
30a
30a
33a
33a
IC
C
C
Signal-layer.
VEE
VCC
VEE
VCC
VEE
VCC
VEE/Contact layer.
32a
32a
31a
32a
31a
32a

FIG.3

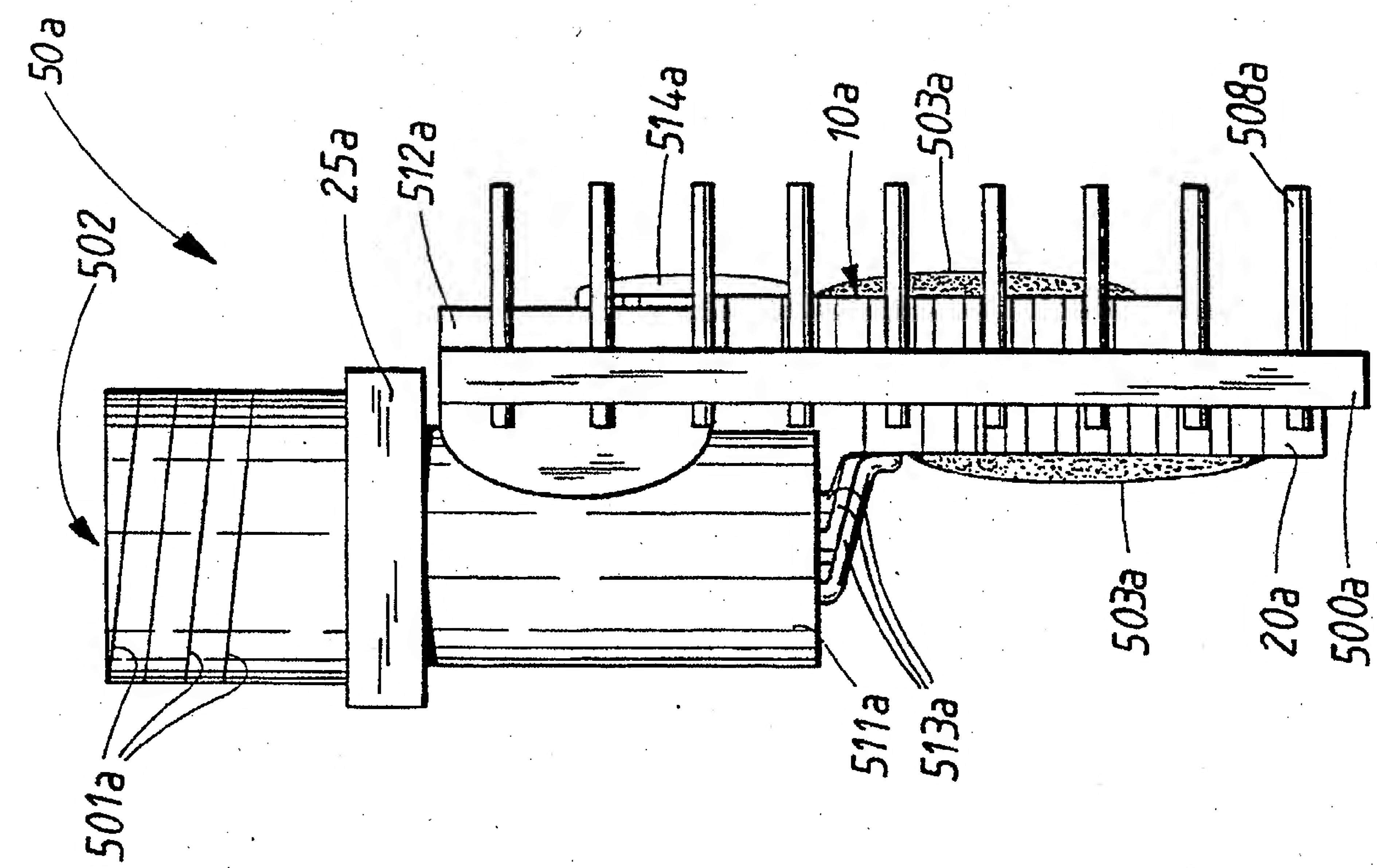

50a
502
25a
512a
514a
10a
503a
508a
501a
511a
513a
503a
20a
500a

FIG.4b

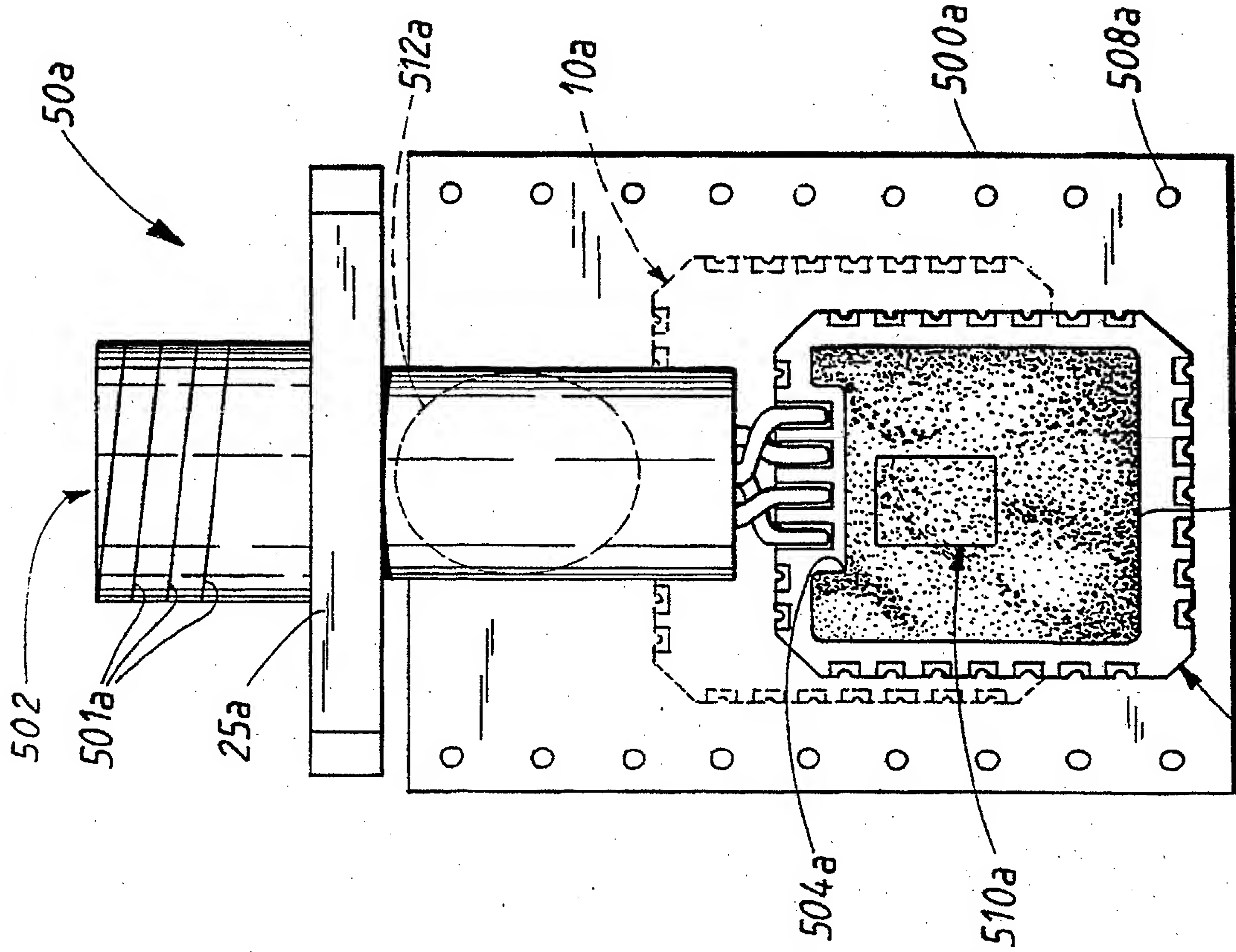

50a
512a
10a
500a
508a
502
501a
25a
503a
504a
510a
20a

FIG.4a

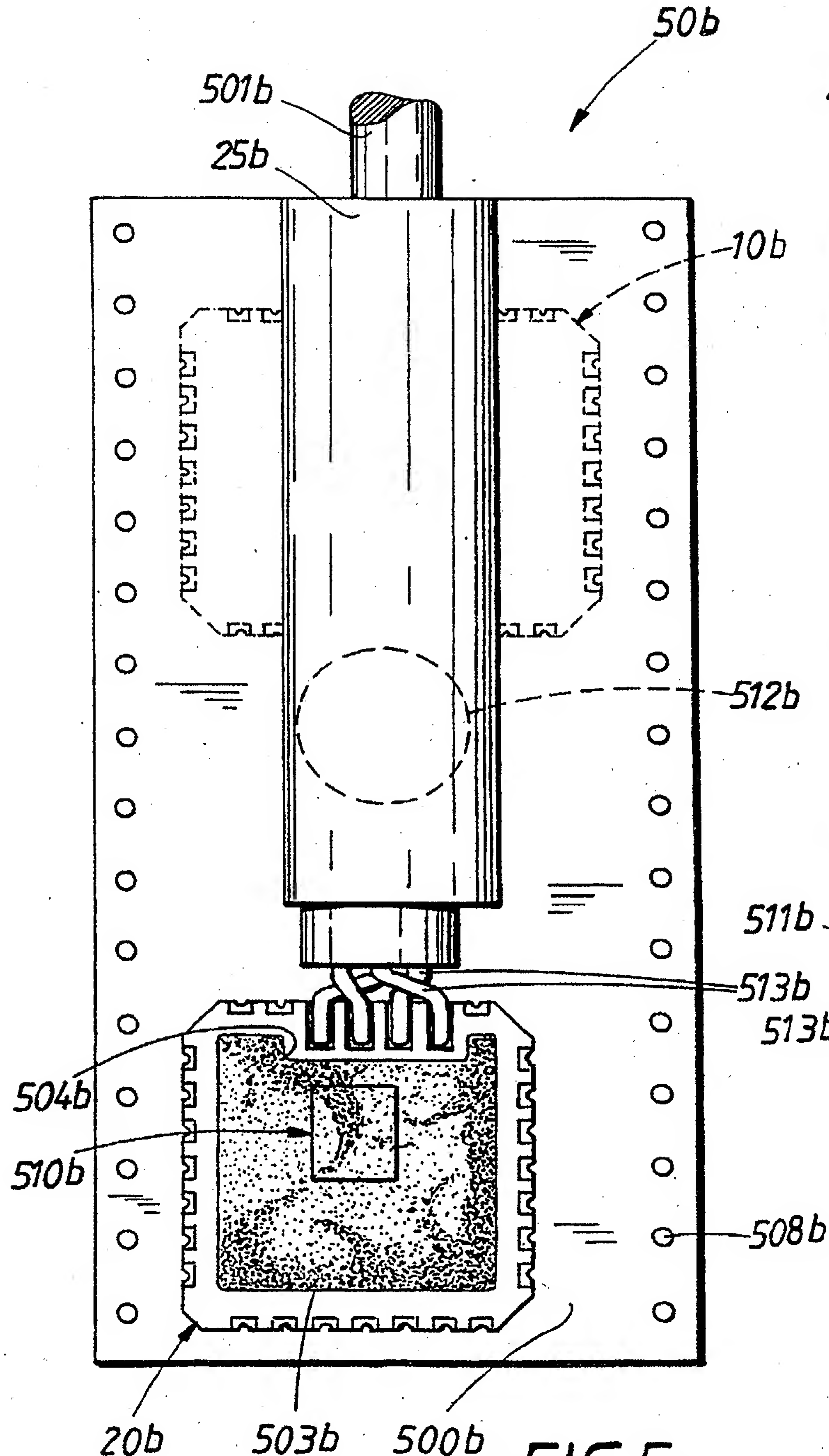

50b
501b
25b
10b
512b
513b
504b
510b
508b
20b
503b
500b

FIG.5a

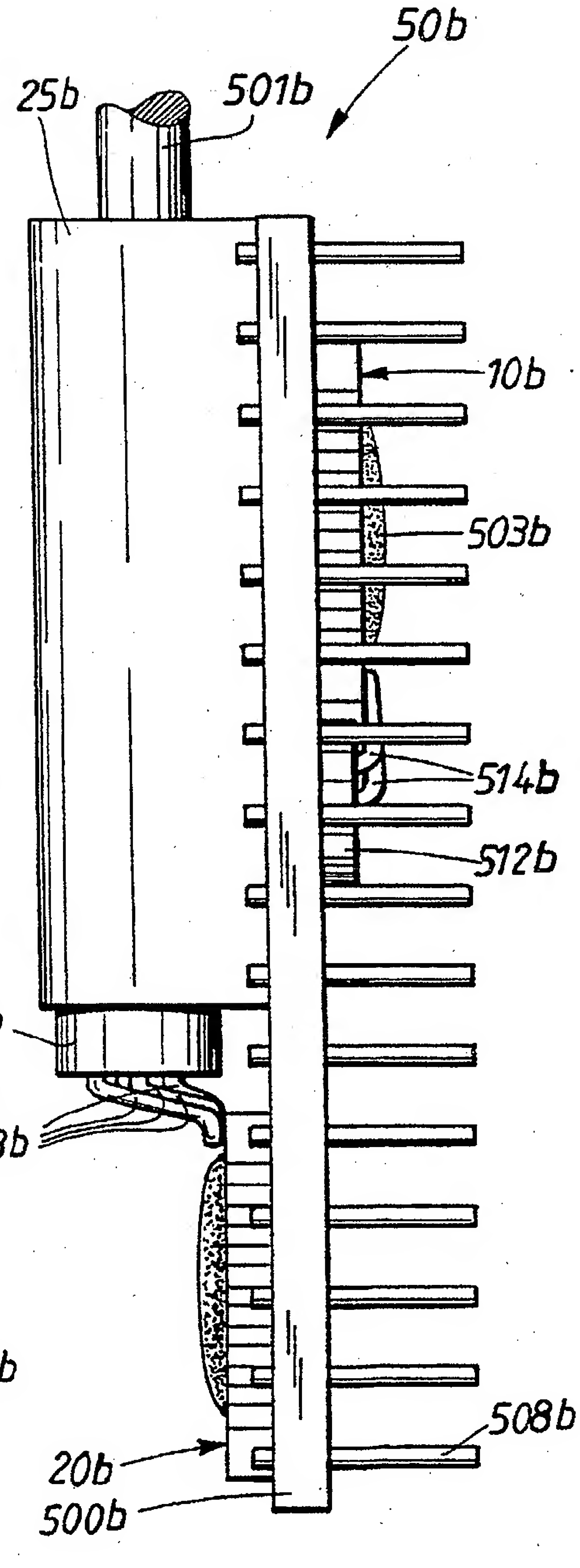

50b
25b
501b
10b
503b
514b
512b
511b
513b
513b
508b
20b
500b

FIG.5b

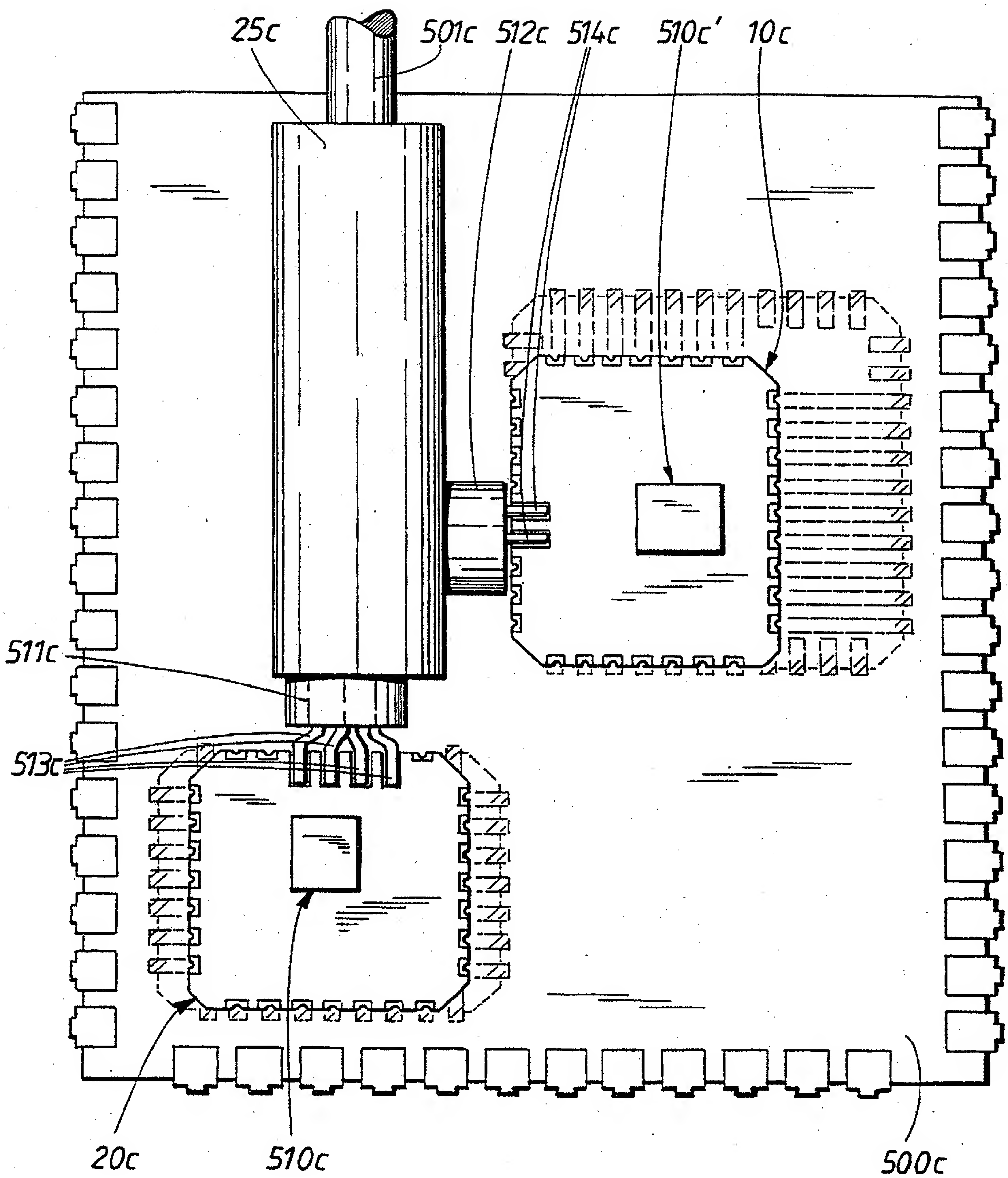


FIG. 6

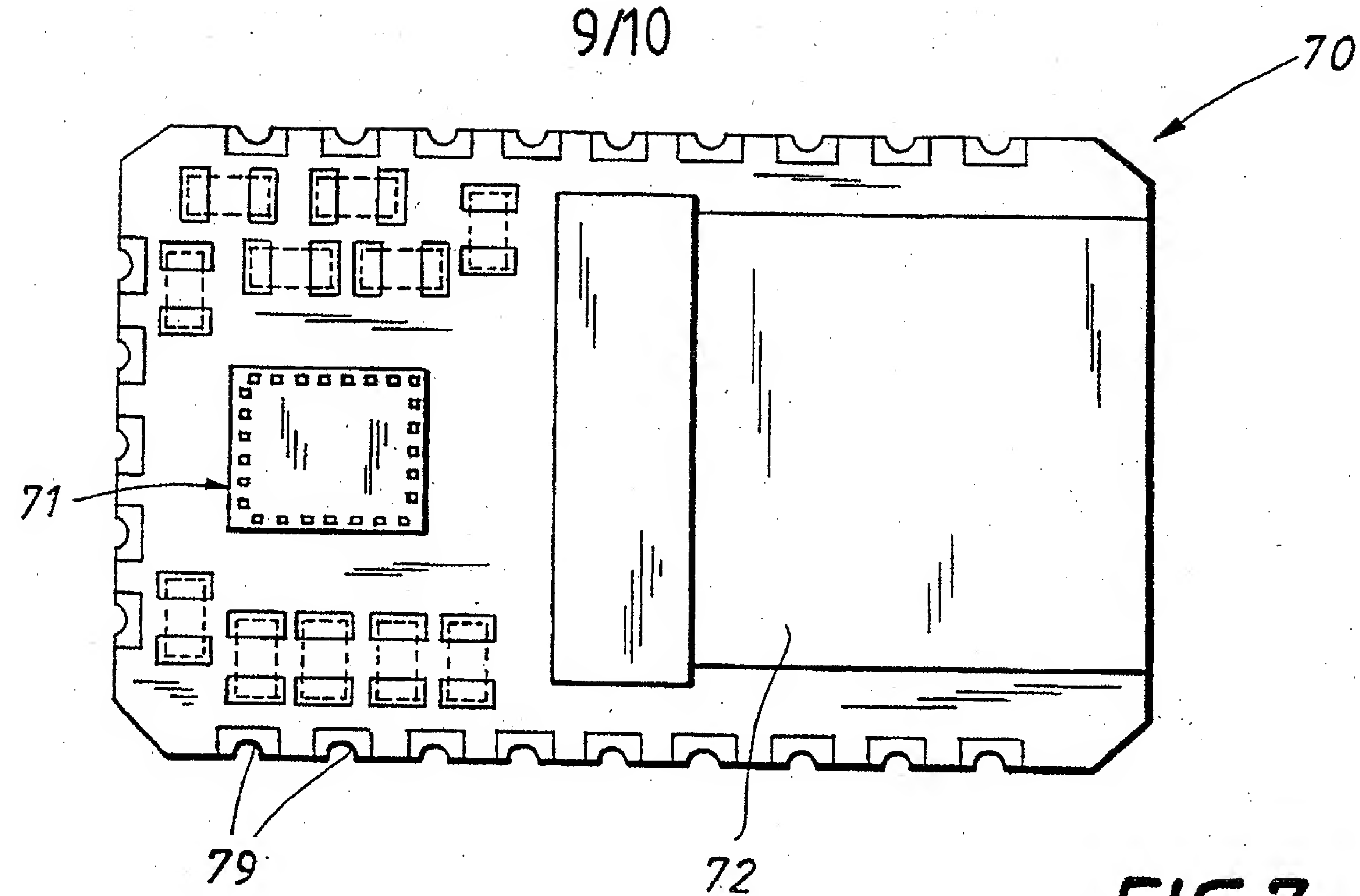


FIG.7a

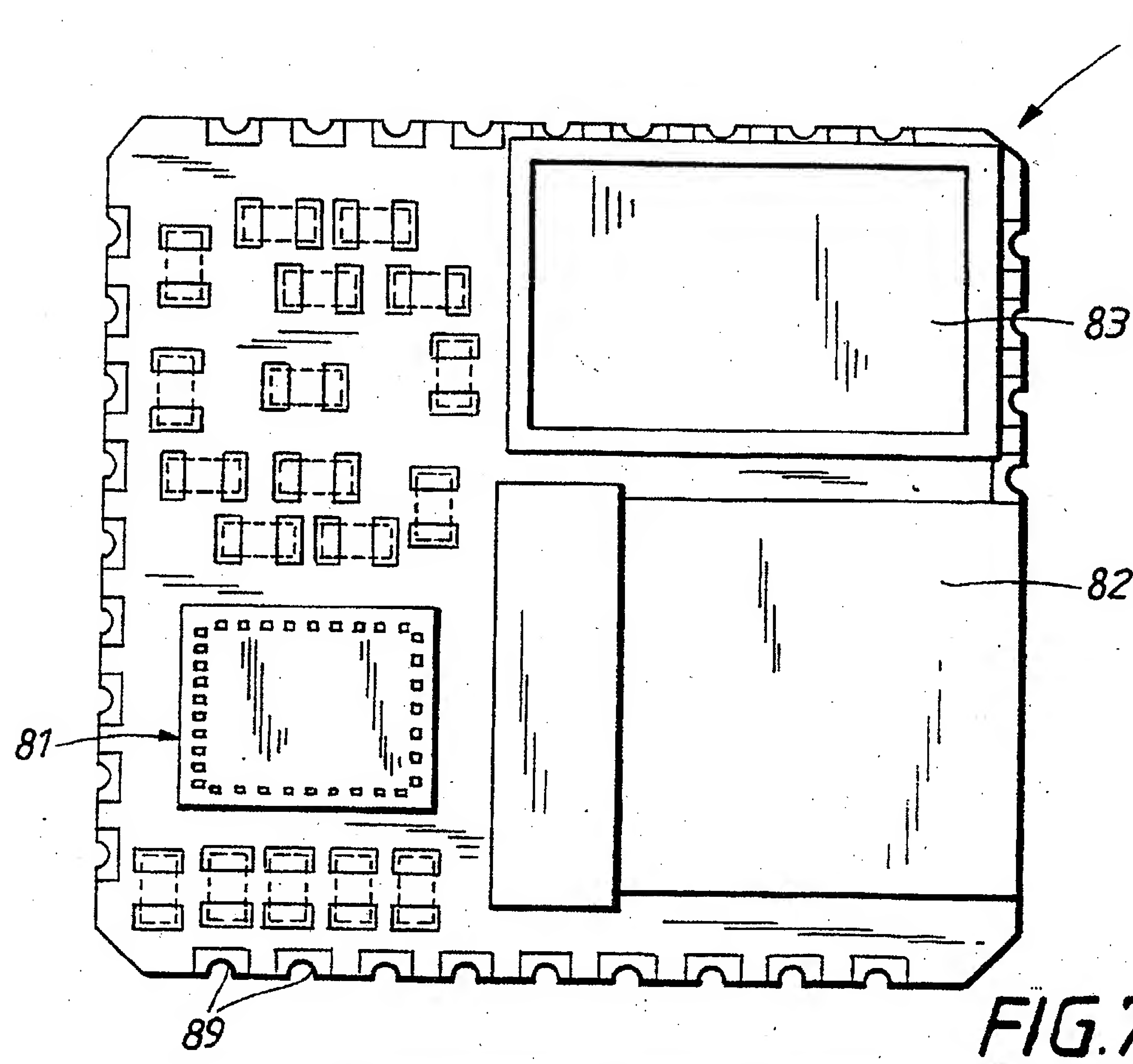


FIG.7b

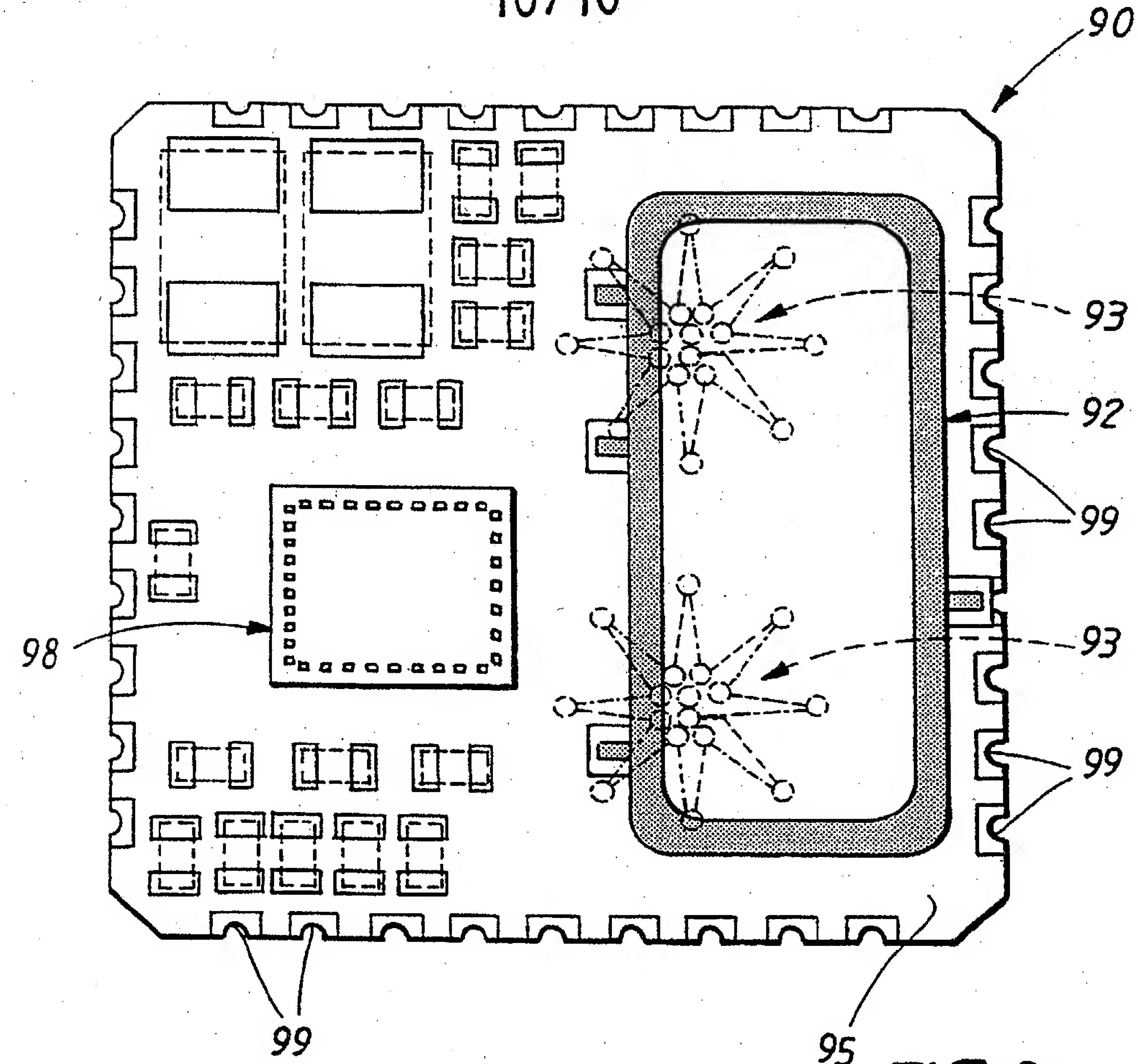


FIG. 8a

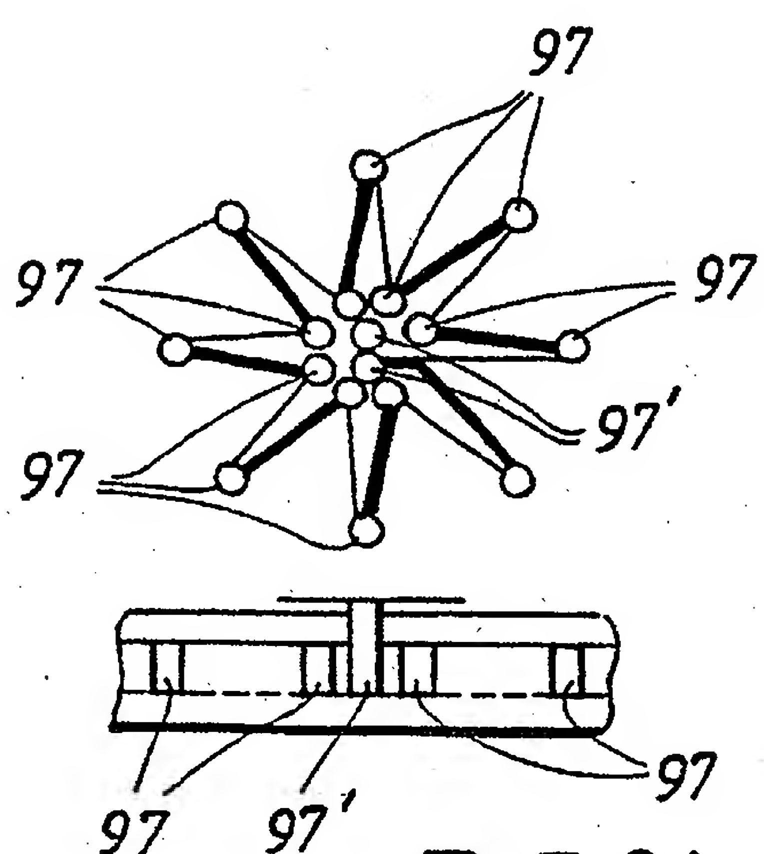


FIG. 8b